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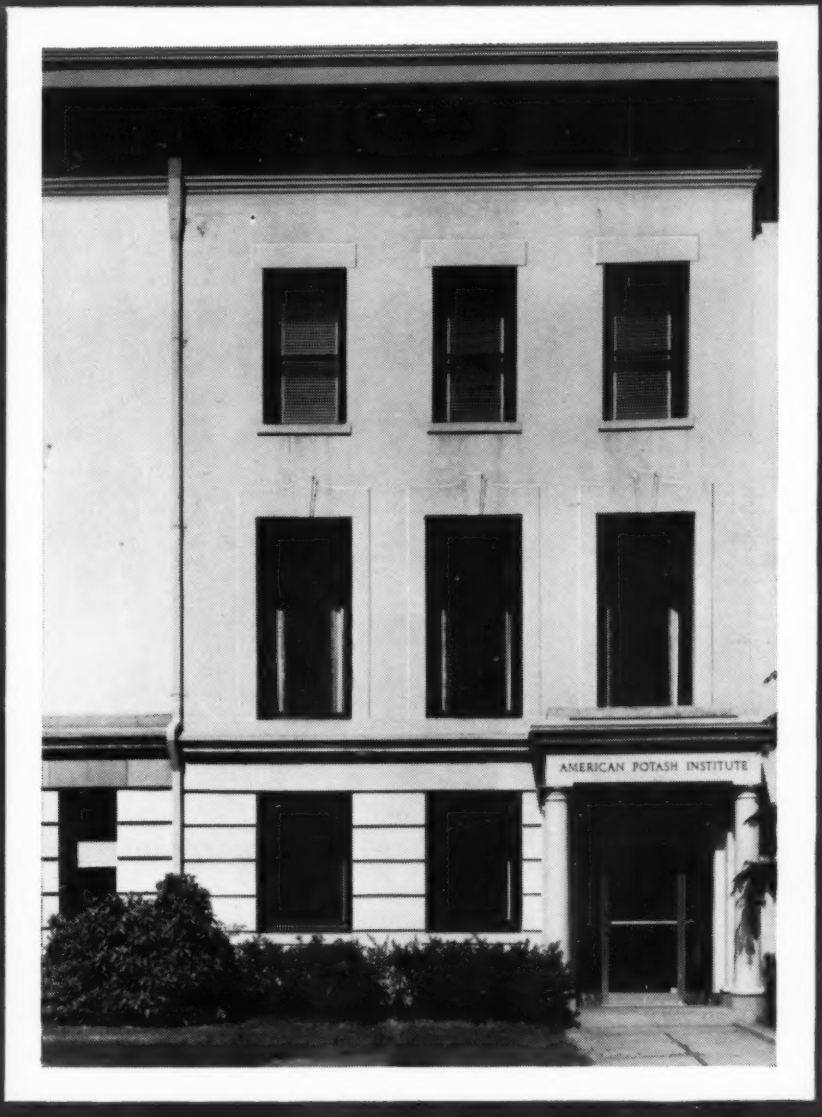

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VOLUME XXXIX NO. 6

TABLE OF CONTENTS, JUNE-JULY 1955

Twentieth Anniversary 3
H. B. Mann, President

The American Potash Institute, What It Does—How It Works 4
J. D. Romaine, Vice President

Potash in the South 10
J. Fielding Reed, Southern Manager

Potash in the Northeast 13
S. D. Gray, Northeastern Manager

Potash in the Midwest 17
W. L. Nelson, Midwest Manager

Potash in the Western States 21
M. E. McCollam, Western States Manager

Potash in Canada 24
R. P. Pennington, Canadian Manager

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VOL. XXXIX WASHINGTON, D. C., JUNE–JULY, 1955 No. 6

Twentieth Anniversary

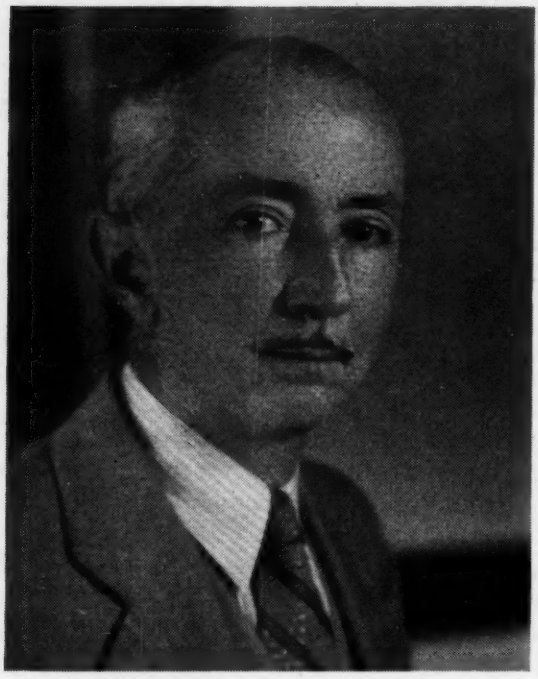
WITH this issue we are commemorating the twentieth anniversary of the American Potash Institute. It is felt that our readers will be interested in a brief account of the organization of the Institute, what it does, and how it operates, together with a summary of what has been achieved during the 20 years toward finding the proper place for potash in a profitable agriculture.

The 20 years have been marked by a splendid spirit of cooperation on the part of the official agricultural research and advisory groups with whom it has been our privilege to work in a common cause. We also are grateful for the support of our member companies whose sympathy with the problems of American agriculture prompted them to continue the support of research even during periods when demand fully equaled the supply of potash.

The American potash industry has made tremendous strides since 1935. In spite of difficulties occurring due to World War II, production capacities were increased with private capital sufficiently to meet substantially all of the potash requirements. A potash famine and skyrocketing of prices, such as were experienced during World War I, were averted.

Research showed that much greater quantities of potash were needed to meet the wartime requirements of our expanding agriculture and to increase the efficiency of crop production in the postwar period. Through the teamwork of research and industry, farmers have been well served during the past 20 years. With efficiency through research still the major keynote, it is to be hoped that the American Potash Institute can participate as cooperatively during the years ahead.

H. B. MANN, *President*



J. W. TURRENTINE, President Emeritus

JOHN William Turrentine retired as President and Chairman of the Board of Directors of the American Potash Institute on December 31, 1948. He was born in North Carolina and received his Ph.B. and M.S. degrees from the University of North Carolina and his Ph.D. degree from Cornell University. In 1954, North Carolina State College conferred upon him the honorary degree of Doctor of Agriculture. Early in his career he joined the U. S. Department of Agriculture as a research chemist and was given the first assignment under the first appropriation made by Congress for potash research. This involved an investigation of known potash raw materials with the purpose of removing the dependence of this country on Germany for potash salts. He designed, constructed, and operated a plant for the extraction of potash from kelp and invented a process for the vacuum cooling and crystallization of potash salts. This development revolutionized the potash industry, which had previously used vat cooling and crystallizing methods. With this background, it was logical for Dr. Turrentine to become the first president of the American Potash Institute, with an avowed purpose "to find the proper scientific place for potash in American agriculture."

Dr. Turrentine is an emeritus member of the American Chemical Society, a member of the American Institute of Chemical Engineers, and a 50-year member of the American Association for the Advancement of Science. He also is a member of the American Planning and Civic Association, Gamma Alpha, and Sigma Xi. He was U. S. Delegate to the Third International Congress of Technology and Chemistry in Agricultural Industries in Paris; Ninth International Congress Pure and Applied Chemistry; Eleventh Conference International Union Chemistry (Councilor) in Madrid; and the Tenth International Congress of Chemistry in Rome. A major objective of his trips to Europe was to familiarize himself with the potash industries of Germany, France, and Spain. In 1937 he was awarded the gold medal of the Academie d'Agriculture de France for his work with potash. He is the author of the books *Potash, Potash in North America,* and co-author with Eckstein and Bruno of *Potash Deficiency Symptoms.*

H. B. MANN, President

PRIOR to assuming presidency of the American Potash Institute, Harvey Blount Mann was manager of its Southern Territory. A North Carolinian, he received both his B.S. degree in Agriculture and his M.S. in Soils at the North Carolina State College. A Ph.D. in Agronomy was conferred upon him by Cornell University, after which he returned to North Carolina State College to serve in the role of Agronomist. His early studies pertained to the use of more concentrated fertilizers, the influence of mineral supplements, and the relation of fertilizer placement to crop stand, growth, and production. He is author or co-author of 35 Federal and State bulletins and articles presenting the result of original work. Included among these are some 20 publications based on original agronomic work with crops important to the South and their response to various plant nutrients in varying combinations, ratios, and methods of application and as influenced by soil types, rotations, etc.

As Southern Manager for the Institute, Dr. Mann conducted the promotional program in strict accordance with fertilizer recommendations of the State Experiment Stations and the U. S. Department of Agriculture. He was in charge of Institute activities in the States of North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Mississippi, Arkansas, Texas, Oklahoma, and Tennessee.

Dr. Mann is a member of the American Society of Agronomy; Soil Science Society of America; Soil Science Society of Florida; American Association for the Advancement of Science (Fellow); Southern Agricultural Workers; Sigma Xi; Sigma Pi; Alpha Zeta; the Chemist Club of New York; Mattamuskeet Club of North Carolina; Kenwood Golf and Country Club and Cosmos Club of Washington; and is a Scottish Rite Mason and Shriner. He is a Trustee of the University of North Carolina and former Director of the North Carolina State General Alumni Association. In 1935 he was a delegate to the Third International Soil Congress, Oxford University, England, and he has visited the universities and experiment stations of England, Scotland, Wales, Holland, Germany, and France. He also has visited and studied the operations of the various European potash mines and refineries.

The American Potash Institute

What It Does — How It Works

By J. D. Romaine, *Vice President*

The American Potash Institute is a unique organization in that it is supported by commercial companies—five of the six leading potash producers in the United States—but is not a trade association in the usual concept of the term. The Institute is a research and educational organization which has for its purpose the promotion of the agricultural use of potash on a basis that is sound and profitable to the farmer. It does not concern itself with legislative, production, or trade matters.

The Institute, organized as a non-profit corporation under the laws of the State of Delaware, began operations July 1, 1935. Its purposes and operation are well set forth in the Articles of Incorporation as follows:

"(a) To promote the efficient and profitable use of potash in agriculture in Cuba, Canada, and in the United States, including Hawaii and Puerto Rico, hereinafter called Institute countries.

"(b) To serve as a medium for the exchange of information on the use and consumption of potash between the members of the Institute, on the one hand, and the several state, federal, provincial, dominion, and territorial agricultural authorities and all others interested in the use of potash fertilizers in agriculture, on the other hand, and cooperate as a unit with other plant-food producers.

"(c) To aid in securing the coordination and cooperation in experimental work and the use of potash between members of the Institute and agricultural workers and between members and state and federal agricultural authorities.

"(d) To conduct research and experimental work with potash and to disseminate practical potash information to members of the Institute, potash distributors, the fertilizer trade, agricultural advisers, and especially the farmer."

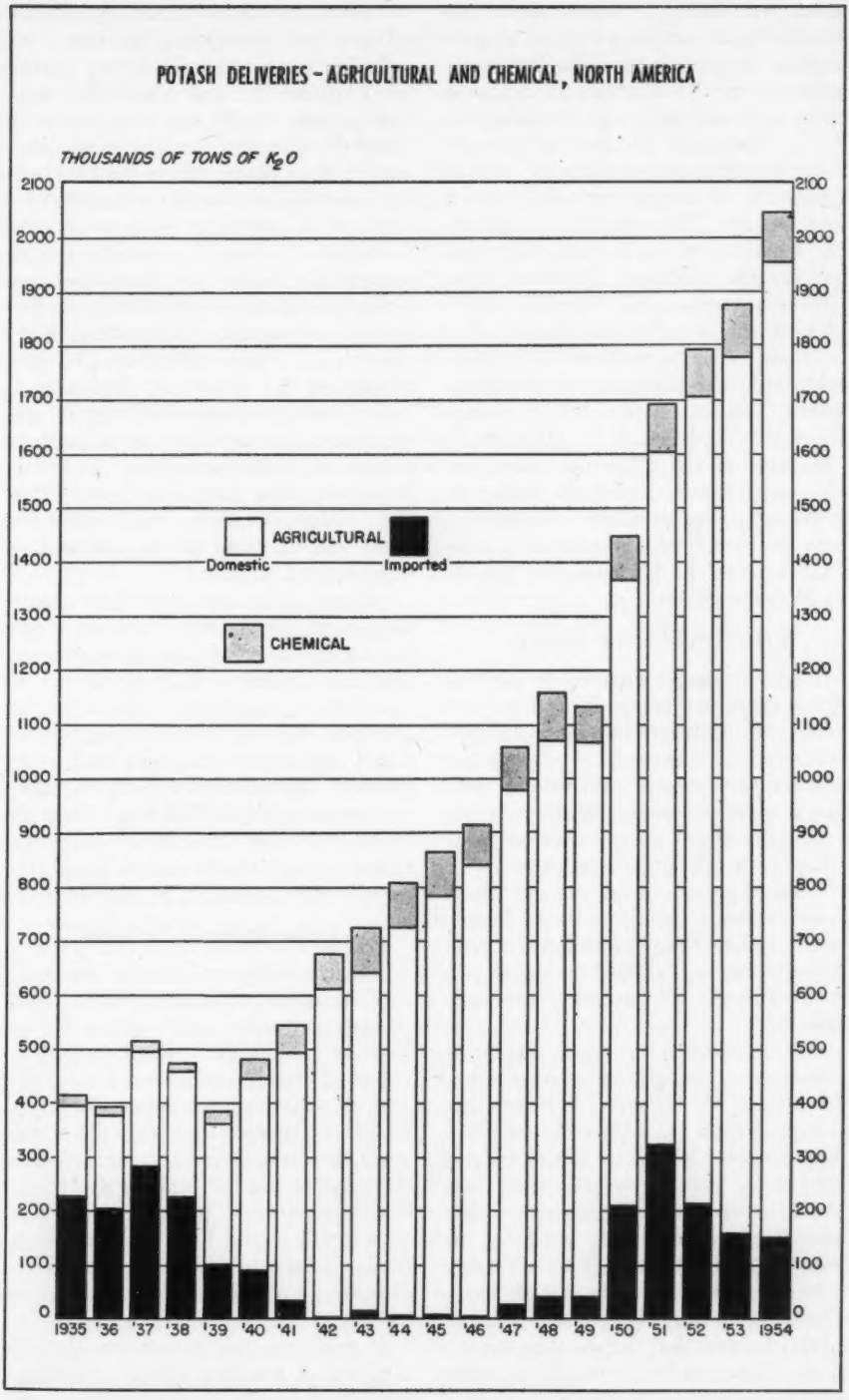
Members and Staff

All the principal units of the potash industry in operation at the time participated in establishing the Institute. These were the American Potash and Chemical Corporation, Potash Company of America, and the United States Potash Company, all American producers, and the N. V. Potash Export My., importers of European potash. The three American companies still are members of the Institute, and the Southwest Potash Corporation and Duval Sulphur and Potash Company became members after they came into production. The outbreak of World War II brought about the dissolution of the N. V. Potash Export My., necessitating its resignation.

The governing body of the Institute is the Board of Directors, consisting of two representatives from each of the five Member Companies and the President. The Board appoints the officers, sets the budget, and determines the general policies to be followed.

The staff consists of 16 agronomists, 2 editors, 2 librarians, and 11 secretarial and clerical employees, a total of 31.

The activities of the Institute are organized under four functional categories, agronomic, economic, informa-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1935 '36 '37 '38 '39 '40 '41 '42 '43 '44 '45 '46 '47 '48 '49 '50 '51 '52 '53 1954

tional, and library. Superimposed on the funcuional organization is a geographic organization. The informational and library activities are centered in the executive offices in Washington, D. C. There are five territories, each under the charge of a manager, who is responsible for all Institute activities in the territory. The office for the Southern Territory is in Atlanta, Georgia; that for the Midwest Territory is in Lafayette, Indiana; the Western States office is in San Jose, California; the Canadian office is in Burlington, Ontario; while the Manager of the Northeastern Territory makes his headquarters in the Washington, D. C. office.

In some of the territories, there are field agronomists, under the direction of the territorial manager. At present there are five field agronomists in the South, two in the Midwest, and two in the Western States.

Fellowships and Grants

In the territories covered by the Institute there are more than 6 million farms and it would be a physical impossibility for the staff of 16 agronomists to make personal contact with even a small percentage of these farms. It has therefore always been a basic policy to work primarily through or with other groups in finding out where and how potash should be used. Fundamental information is developed mostly through research fellowships and grants to agricultural colleges and experiment stations.

This fellowship program might be considered as the foundation of all other activities of the Institute. Information on how potash can be used most effectively in areas where its use already is established, exploration of new areas where its use can be developed, and the investigation of new crop outlets in all areas has to be obtained if potash usage is to be increased on a sound basis. When the Institute began its activities, it was decided that rather than set up its own laboratories, it would be more effective to utilize the excellent facilities already available in the agricultural colleges and experiment stations.

Budgetary limitations do not permit the Institute to maintain fellowships continuously in all states and provinces. They therefore are rotated, with selection of those places where the problems are most urgent, or where facilities for work on a particular project are most favorable. In the 20 years of Institute sponsorship, fellowships have been supported in 38 states and provinces. The projects, of variable duration and scope, numbered 90 and more than 200 men conducted the investigations, in most cases leading to advanced degrees for the investigators. The total amount of money paid the institutions for these fellowships and grants was about $750,000. More detailed information on them will be given in the sectional articles in this issue.

Projects of a more practical nature, frequently in the form of demonstrations comparing different fertilizer practices, are conducted in cooperation with agricultural extension forces, Soil Conservation Service, county agents, vocational agriculture teachers, and other groups. The total spent for such activities has been about $500,000. Thus the funds expended directly for investigational projects of one nature or another have totaled about $1,250,000.

Informational Services

The economic activities of the Institute are rather modest in scope. They consist primarily in compiling for release to the public current records of potash deliveries in Institute countries and a series of wholesale prices of fertilizer materials and crops. The basic work in compiling the price records, done under a grant at Cornell University, was recently brought up to date by a grant at the University of Maryland. This is probably the oldest series of fertilizer materials prices in the country.

In making information on the efficient use of potash available to as many interested people as possible, the Insti-

tute has employed the more important means, including publications, motion pictures, radio, television, and advertising. Through these channels this service has been directed to two audiences—the official agricultural advisers and those whom they advise.

The monthly magazine, *Better Crops With Plant Food,* is edited primarily for the advisory groups—the county agent, teacher of vocational agriculture, members of the Soil Conservation and other Government Services, staffs of colleges and experiment stations. In it are presented the results of research and experimental work in soil and crop management in relation to a proper use of plant food, written for the most part by the authorities who did the work. In 1935 the circulation of this magazine was 14,000. It now is 24,000.

Two books, *Diagnostic Techniques for Soils and Crops* and *Potash Deficiency Symptoms,* have furthered information about potash. In the former, eminent scientists provided chapters to bring together in one volume what was known about diagnosing soil fertility and crop nutrition for optimum production. The 10,000 edition, underwritten and published by the Institute, was rapidly sold out. In the other book, the Institute collaborated with French and German scientists in a volume printed in the three languages and illustrated with many color plates. This book also is no longer available.

Potash News Letters, a timely mimeographed service, are issued regularly to circulate in the various territories items on latest research involving efficient fertilization. These letters, together with more than a half million reprints of popular articles from *Better Crops With Plant Food* annually provide information for the farmers.

Advertising in the important farm journals has supported official recommendations on the use of plant food. Farmers are also reached with motion pictures pertaining more particularly to methods for determining potash and other fertilizer requirements. All of these films, from time to time, have been televised. Another visual aid given wide distribution was a set of colored wall posters, one showing the amounts of the three major plant foods utilized by good yields of 20 important crops and the other three showing typical potash-deficiency symptoms on corn, cotton, and legumes. Similar information on various crops illustrated in black and white had been circulated in thousands of circulars prepared by the Institute for distribution to farmers through the fertilizer trade.

A direct service to the press has been maintained for news of interest involving potash. Releases on deliveries of potash salts and agronomic stories have served their purpose in keeping up to date the information on progress in potash usage.

With these services as well as voluminous correspondence and talks before agricultural gatherings and personal contacts, the Institute staff has attempted to disseminate to the interested public the assembled agronomic, economic, and statistical information on potash in agriculture.

The library maintained by the Institute in its Washington Office contains over 200,000 bulletins, books, theses, and periodicals. It is a rather specialized library, devoted mostly to literature on soil fertility, crop production, and related subjects. Literature lists and annotated bibliographies of current work on potash in agriculture are issued for use by research workers and other libraries.

Expanding Market

The potash producers who support the American Potash Institute have invested in it a total of more than $7,400,000 over the 20 years of its existence. This is a sizable sum to spend on the development of a market, but the results would appear to have justified it. In 1935, agriculture in North America took about 393,000 tons K_2O. In the calendar year 1954, the same

(*Turn to page* 38)

Potash in the South

By J. Fielding Reed, Southern Manager

THE past 20 years have seen a tremendous change in farming practices in the South. Mechanization has largely replaced the mule. Diversification of crops has reduced emphasis on cotton. Shifting populations and the influx of industry have gone hand in hand with improved education and hence a better informed farmer. Acreage controls, crop surpluses, and wars have changed the type of farming and the acres in various types of crops.

As a result, far greater emphasis has been placed on efficient farming. In the South with its vast areas of low fertility soils, efficient farming means most of all efficient use of fertilizers. Efficient usage has revolved around the development and distribution of information which shows that farmers should apply enough fertilizer so that their cost per unit of production will be decreased and their net returns per acre increased.

In an attempt to develop this story and then to tell it, the staff members of the American Potash Institute have worked hand in hand with members of the fertilizer industry and with the agricultural leaders in the various state and federal agencies that strive to improve the farmers' standard of living.

Cooperative Programs

Research Fellowships: Research fellowships in the South mark one of the Institute's best investments in the progressive agriculture of the area. These fellowships have served two main purposes:

(1) To help in the training of well-qualified soil and plant scientists. These men today occupy important positions of agricultural leadership, and in many instances their advanced college training would not have been possible without financial assistance of some sort.

(2) To assist in investigations, both fundamental and applied, of soil and plant nutrition problems, especially those dealing with potash utilization.

In the 11 states in this area more than 50 students have worked under potash fellowships. At times, particularly during World War II when students were not available, these funds helped to support research projects carried on by staff members at their institutions. As information unfolded from these investigations, the colleges, through their research publications and through extension workers, and together with the Institute, put this in the hands of the fertilizer industry and farmers.

Over the past 20 years, the projects

TABLE I.—INCREASE IN PASTURES IN GEORGIA

	Acreage 1925	Acreage 1954
Permanent pasture	811,000	3,450,000
Winter pasture	Practically none	1,000,000
Kudzu	Practically none	125,000
Lespedeza sericea	Practically none	250,000
Alfalfa	2,000	15,000
Annual lespedeza	6,000	750,000
Ladino clover—Tall fescue	None	300,000

This table from a recent circular of the Georgia Agricultural Extension Service shows the phenomenal increase in pastures in Georgia in the last thirty years.

in which the Institute has had a part have resulted in a great deal of information on better fertilization practices. For instance, in 1935 information on pasture fertilization was rather meager in the South, and recommendations usually involved lime and a relatively light application of superphosphate. Fellowship projects have dealt with pasture fertilization in seven states in the South. Research has pointed out that better fertilization is one of the keys to better pasture production. Figures 1 and 2 show that faith in pasture fertilization has been justified.

Table I is from a recent Georgia Extension Circular and shows the increase in pastures in Georgia since 1925. If the present acreage of pastures in Georgia were fertilized according to the minimum recommendations of the University of Georgia, it would require 1,200,000 tons of fertilizer per year. According to the Georgia agronomists, these are minimum figures for maximum economic production.

Other work was devoted to the problems of soybean fertilization. It was found that even on an infertile soil a balanced program of lime and phosphate-potash fertilization would greatly increase the yield and quality of this important crop (Figure 3).

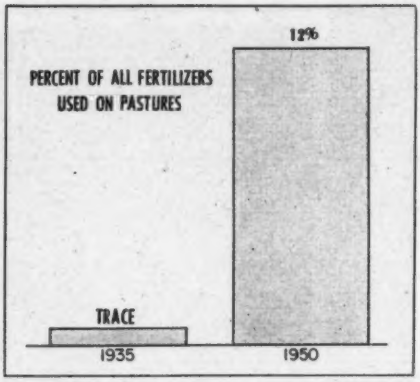

Fig. 1. Twenty years ago the amount of fertilizers used on pastures was negligible. Now it is over 12 per cent of all fertilizers. Potash fellowships have dealt with pasture fertilization in many states in the South over these years.

Diagnostic Aids: Closely associated with the fellowship program has been the Institute's interest in soil and plant tissue testing as means of evaluating soil fertility levels and for helping to determine fertilizer needs.

Fig. 2. Twenty years ago in the South, fields like that on the left were referred to as pastures. Now research has shown that clovers thrive if adequate amounts of lime, phosphate, and potash are applied as on the right. Typical recommendations are 800 to 1,000 lbs. of 3-12-12 at planting with annual applications of 400 to 500 lbs. of 0-14-14 or 0-10-20.

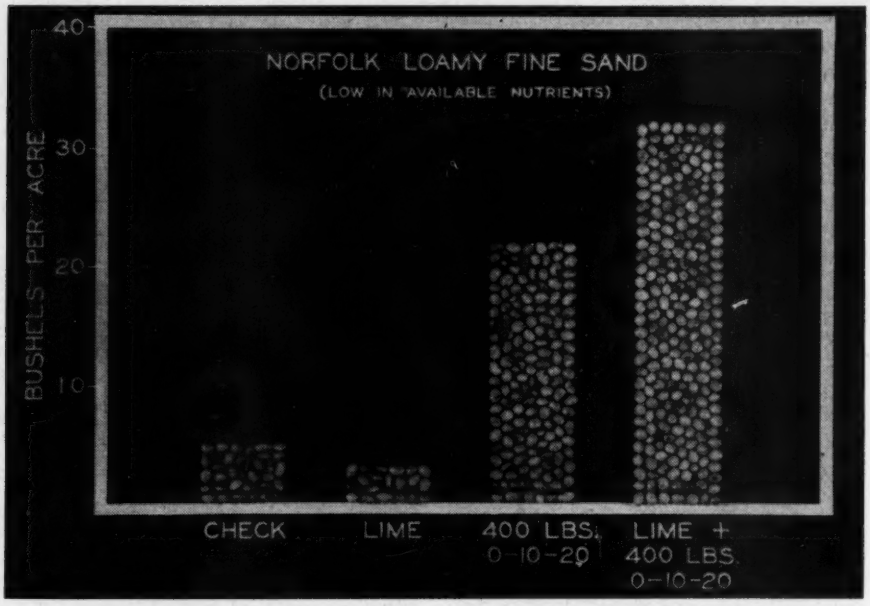

Fig. 3. A research grant of the American Potash Institute was devoted to work on soybean fertilization. This chart appeared in a North Carolina publication summing up that research and pointing out the need for fertilizer and lime on soybeans.

A review of the project titles of early potash fellowships shows that many of them dealt with basic and fundamental work relative to the use of soil testing. In North Carolina, Louisiana, Oklahoma, Georgia, and Tennessee "correlation of crop response" with chemical tests was studied.

Twenty years ago there was in the South practically no soil testing conducted as a farm service. In 1954 it is estimated that 350,000 soil samples were analyzed for Southern farmers. Every state in the South has a soil-testing service. What this has meant to the fertilizer program can be seen in Figures 4 through 6.

Demonstrations: Demonstrations have long been one of the best methods of selling new practices to farmers. "Seeing is believing" certainly applies to good fertilizer practices. The Institute in cooperation with county agents, vocational teachers, Soil Conservation Service, Tennessee Valley Authority, and other agricultural agencies has used demonstrations extensively in selling the story of recommended fertilizer practices. Cooperatively setting up, supervising, and showing these demonstrations has been a privilege which has been among the chief duties of the Institute agronomists over the South.

It should be emphasized that these demonstrations are always worked out cooperatively with the state agricultural agencies and that they are not designed simply to show the value of potash, but to promote a sound, well-balanced fertilizer program along with other good farming practices.

As an example of the effectiveness of a demonstration program, a recent cooperative effort in Tennessee might be cited. This was written up in the February 1954 issue of this magazine. In Tennessee, alfalfa acreage had dropped from 183,000 acres in 1949 to 100,000 acres in 1952. Growers reported the decline as due to low pro-

(*Turn to page* 39)

Potash in the Northeast

By S. D. Gray, Northeastern Manager

WHEN the Institute was organized in 1935, the current rate of consumption of potash in the United States and Canada was only 313,000 tons K_2O per annum. The Northeast Territory in that year consumed 81,152 tons K_2O. After careful scrutiny of figures on fertilizer usage and recommended ratios, an objective potential tonnage goal for the entire country was set at 500,000 tons and for the Northeast 133,000 tons K_2O. Examination of the consumption figures in Table I shows that the goal set for the Northeast had been achieved in less than 10 years and that by the 20th year potash consumption in the territory had increased 268 per cent (see Figure 1). Other data of interest in the above-mentioned table and figure round out the picture nicely and require no special explanation.

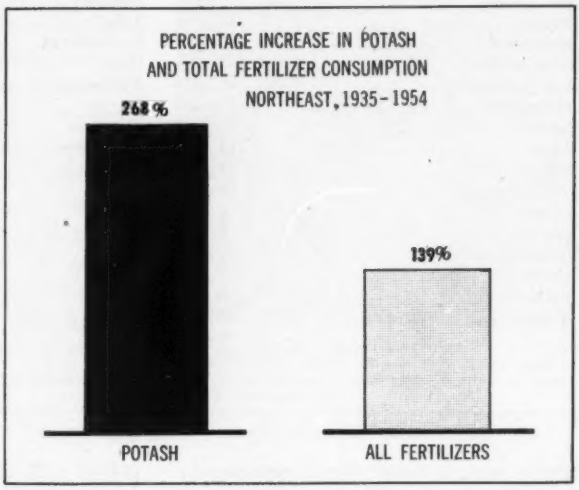

Fig. 1

In the 13 states comprising the Northeast Territory, an enormous potential for increased potash usage exists. Of approximately 60,000,000 acres (see Table II) devoted to farm crops, more than 75 per cent of the potash sold is used on less than 2,000,000 acres in the Group A classification,

TABLE I.—CONSUMPTION OF FERTILIZER IN NORTHEAST

Year	Mixed fertilizers (Tons)	Materials (Tons)	Potash (K_2O) (Tons)	All fertilizers (Tons)
1935	965,277	279,246	81,152	1,441,760
1940	1,258,288	569,711	106,701	1,827,999
1945	2,108,650	606,173	180,206	2,714,823
1950	2,467,982	670,775	217,121	3,138,759
1955	2,946,043	497,401	298,734	3,443,444

TABLE II.—CROP ACREAGE CHART FOR NORTHEAST TERRITORY

Group A. Crops using normal amounts of potash		*Group B.* Crops using low or no potash	
Crop	*Acreage*	*Crop*	*Acreage*
Potatoes (Ir.)	971,000	Pasture	30,000,000
Tobacco	173,237	Hay (tame)	13,545,000
Peanuts	160,000	Corn (field)	5,010,000
Tomatoes	102,000	Wheat	2,917,000
Potatoes (Sw.)	70,000	Oats	2,708,000
Peas (canning & fr.)	70,000	Apples	1,210,000
Cotton	56,818	Alfalfa	649,381
Cabbage	55,000	Buckwheat	478,000
Strawberries	50,000	Rye	277,000
Snap Beans	40,000	Soybeans	250,000
Asparagus	20,000	Barley	243,000
Spinach	20,000	Peaches	165,000
Onions	15,000	Corn (Sw.)	90,210
Cantaloupes	13,000	Cowpeas	87,000
Cucumbers	12,000		
Lettuce	9,000		57,629,591
Peppers	8,000		
Watermelons	7,000		
Celery	7,000		
Cauliflower	6,000		
Carrots	5,000		
	1,870,055		
		Grand total	59,499,646

which enjoys favorable recommendations for potash. The crops in Group B use less than one fourth the total potash sold in the territory. The most spectacular opportunity for increased potash usage is with the large acreage

Fig. 2. Long rows of well-fertilized potatoes in bloom make a beautiful landscape. Fertilizers in 1-1-1, 1-2-2, 1-2-3, and 1-3-3 ratios find wide application. One ton per acre is a fairly standard rate of application.

crops in this group—(1) hay and pastures, (2) corn, and (3) fruit trees. It is to these crops in this high potential group that the Northeast staff has from the beginning directed its research and educational efforts.

In promoting the efficient and more profitable use of potash in Northeastern agriculture every possible influence factor has been critically analyzed and used to the best possible advantage. The most effective have been: (1) Research projects designed to increase knowledge of the functions and behavior of potash in soils and plants; (2) cooperative experimental work to facilitate extension and teaching programs involving the use of potash; (3) chemical analysis of soils and plants as a means of determining their fertility status and fertilizer requirements; (4) visual symptoms of potash deficiency using charts, color slides, and films; and (5) educational publicity for the purpose of taking the findings of research workers to the grass-roots level —the farmer.

Fig. 3. Severe potash deficiency in the apple shoot at the right shows the short, slender growth and burned leaves characteristic of severe potash shortage.

Research Fellowships

Since the Institute came into being, 25 research projects have been inaugurated in the Northeastern States.

Fig. 4. This alfalfa-brome pasture provides an abundance of highly nutritious feed for this herd of Hereford steers. Legumes in association with grasses markedly increase yield and quality of herbage. When the percentage of legumes is maintained between 30 and 40 per cent, the danger of bloat is not very great.

Fig. 5. Soil tests show this soil is low in potassium. When potash fertilizer was applied (left), the yield was more than doubled.

Without exception these projects have served a useful purpose and have greatly increased knowledge of the functions and agronomic value of potash. The research results quickly found a place in teaching and extension programs in the states where conducted.

(*Turn to page* 48)

Fig. 6. This stand of ladino on the Agronomy Farm at Storrs, Connecticut, is 15 years old. Management: Mowed when 8 inches to 2 inches; fertilization every year—150 lbs. of 46 per cent superphosphate and 250 lbs. 60 per cent muriate of potash; one ton of limestone every fifth year.

Potash in the Midwest

By W. L. Nelson, Midwest Manager

ONE of the most outstanding developments in agricultural practice in the United States has been the greatly increased use of nitrogen, phosphorus, potassium, and lime in the Midwest. Certain of the soils in this area were very deficient in one or more nutrients. On the other hand, many of the soils have been recognized as some of the most fertile in the country, but there has been a growing realization of the need for replacement of the plant nutrients removed in crop production. The increased use of lime and fertilizer which has taken place in the past few years appears to be only a start in such a replacement.

Usage of nitrogen, phosphorus and potassium

Considering the 13 Midwestern States, the N, P_2O_5, and K_2O consumption has increased rapidly since 1935 (Figure 1). The data for the states east of the Mississippi River, Ohio, Indiana, Illinois, Michigan, Wisconsin, and Kentucky as a group, show that the consumption of K_2O now exceeds the consumption of available P_2O_5 (Figure 2).

In the section of the Midwest west of the Mississippi, usage of plant nutrients is increasing rapidly, with N and P_2O_5 consumption rising somewhat faster than K_2O. Potassium tends to be present in greater quantities in soils in lower rainfall areas, and nitrogen and phosphorus are more limiting than potassium. However, in such areas increased yields resulting from nitrogen and phosphorus applications will increase the need for supplementary applications of potassium in more and more of these soils.

The consumption data for K_2O by states over the past 20-year period in Table I reveal where the greatest increases have occurred. Increases in Illinois, Indiana, and Ohio have been particularly striking. Kansas, Nebraska,

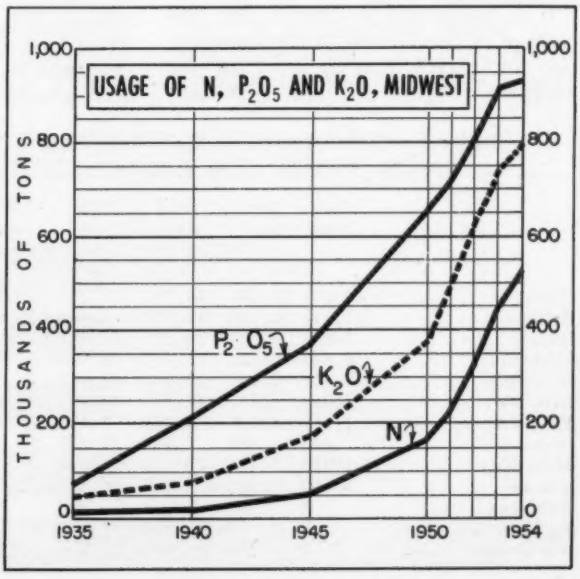

Fig. 1. The consumption of N, P_2O_5, and K_2O has been increasing rapidly since 1935.

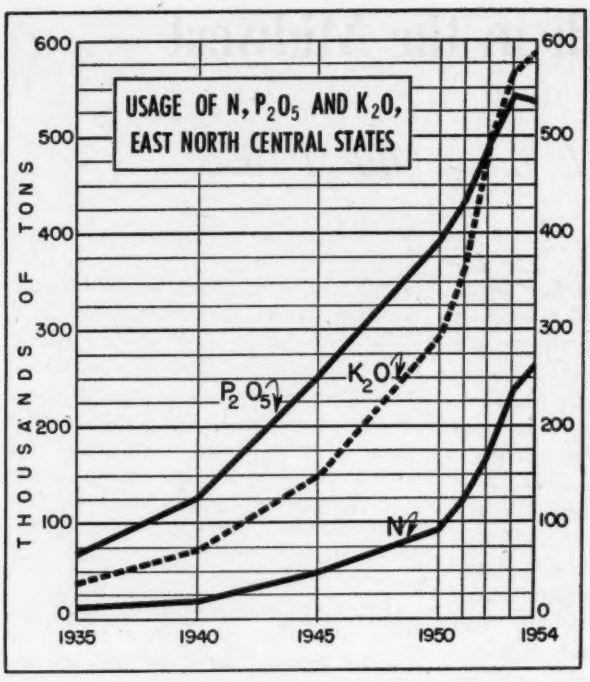

Fig. 2.· In the East North Central States the consumption of K_2O now exceeds that of available P_2O_5.

South Dakota, and North Dakota as yet use very little potassium.

It is interesting to observe the percentage of the United States consumption of potash that is used in the Midwest (Figure 3). In 1935 only 13 per cent was used in the Midwest while in 1954 the proportion had risen to 46 per cent.

N, P_2O_5, and K_2O Content of Mixed Fertilizers: In the Midwest as a whole, the total nutrient content of mixed fertilizers has increased steadily since 1935, from a total of 20.88 per cent in 1935 to 32.29 per cent in 1954 (Figure 4). While part of this is related to the increase in N and P_2O_5, the greatest share of the gain is due to the increased K_2O content, i.e., from 6.35 per cent in 1935 to 13.0 per cent in 1954. The eastern section of the Midwest shows similar trends, with the gain in K_2O content being still more pronounced. In the western section of the Midwest, while the content of all the nutrients has been increasing, the gains in N and P_2O_5 have been greater.

TABLE I.—CONSUMPTION OF K_2O BY STATES IN MIDWEST (1935-54)

	1935 tons	1940 tons	1945 tons	1950 tons	1951 tons	1952 tons	1953 tons	1954 tons
Ohio	12,311	22,744	46,190	80,383	98,768	114,098	130,924	130,873
Indiana	11,213	24,990	46,265	81,408	106,060	125,906	148,921	162,423
Illinois	1,281	4,323	18,038	49,584	77,243	118,134	144,465	151,955
Michigan	6,545	12,642	24,411	42,198	53,123	64,708	76,297	76,464
Wisconsin	2,111	5,699	21,981	44,967	58,661	56,808	64,062	71,803
Kentucky	2,048	3,347	11,638	30,497	34,784	49,332	51,881	57,961
Missouri	1,142	2,029	6,761	23,170	38,105	48,760	59,146	64,226
Iowa	460	882	7,517	15,059	20,019	24,111	35,503	45,525
Minnesota	1,216	1,494	6,082	18,981	21,670	24,099	29,774	37,556
Kansas	80	205	466	1,324	2,372	2,946	3,856	3,979
Nebraska	4	17	4	193	324	458	1,072	1,698
So. Dakota	3	3	22	35	82	150	142	217
No. Dakota	1	19	379	1,205	1,038	1,560	1,437	1,275
Midwest	38,415	78,394	189,754	389,004	512,249	631,070	747,480	805,955

Trends in Grades: The trend toward fertilizers higher in potash is illustrated by the East North Central States—Ohio, Indiana, Illinois, Michigan, and Wisconsin (Figure 5). Before 1930, 2-12-2 was more popular than 2-12-6. Now 2-12-6 has practically been replaced by 3-12-12. It appears that 3-12-12 will gradually be replaced by 4-16-16 and 5-20-20. Similar trends are taking place in other states.

Use of Potash Materials: In 1949, 16 per cent of the potassium used in Illinois was applied as materials (Figure 6). In 1954, 38 per cent was so applied. This rapid change has resulted from a realization that some soils were originally low or were being depleted in potassium and that an effective means of supplying the large amounts needed for corrective purposes was through broadcast applications of a material high in K_2O.

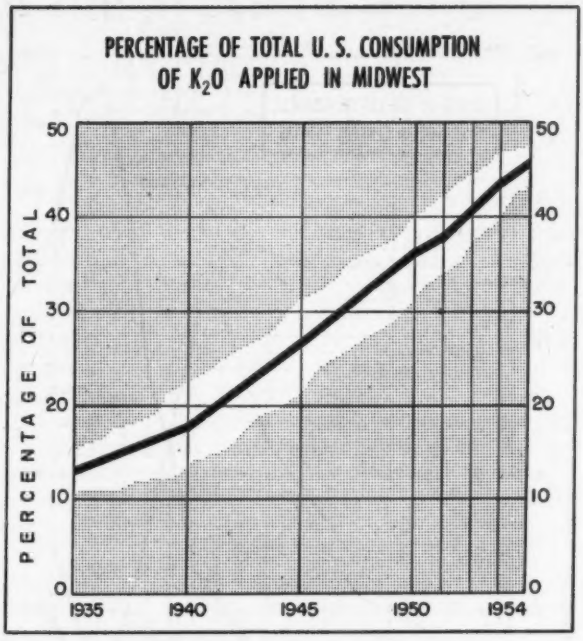

Fig. 3. A steadily increasing percentage of the U. S. potash consumption is being applied in the Midwest.

Some developments leading to increased use of plant nutrients: It should be of interest to review, on a calendar basis, some of the events, new developments, and trends which prob-

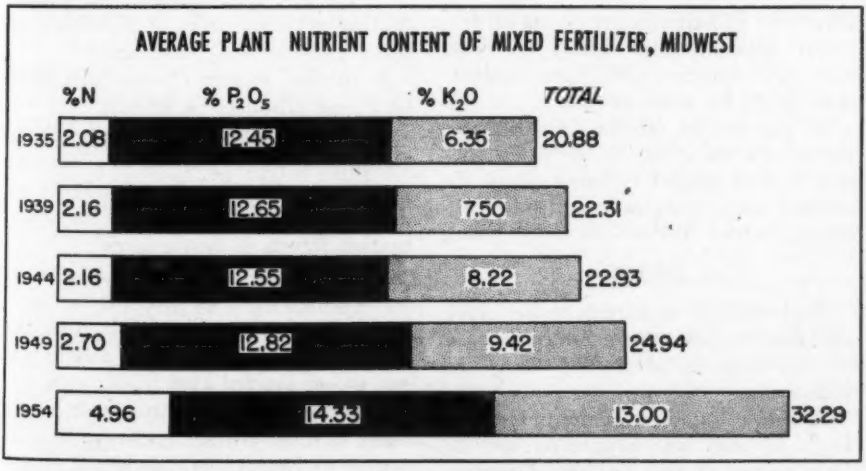

Fig. 4. The total nutrient content of mixed fertilizers in the Midwest is increasing, with the greatest share of the gain being due to potash.

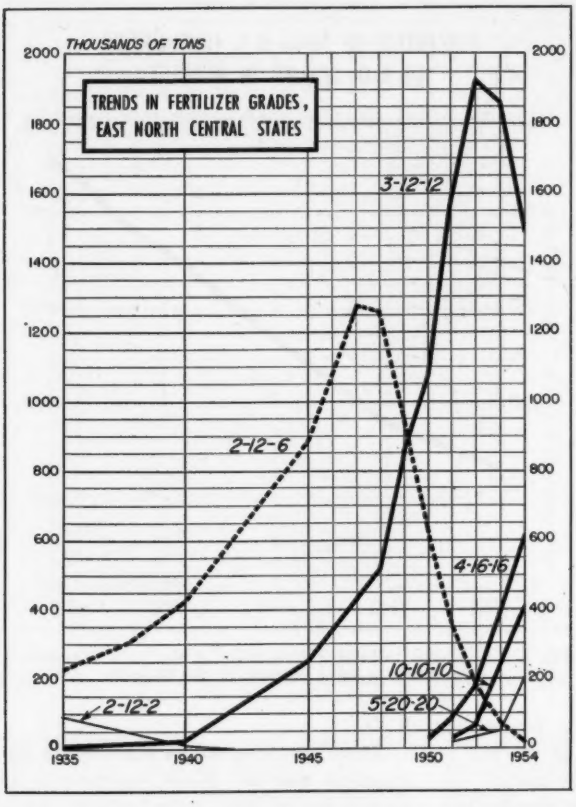

Fig. 5. The 2-12-2 was replaced by 2-12-6 and then the 2-12-6 by 3-12-12. Now 3-12-12 is being replaced by such fertilizers as 4-16-16 and 5-20-20.

ably have had significant effects on fertilizer consumption. Many of these new developments will have measurable effects for years to come.

At the risk of omitting equally important events, a few of the milestones which have helped to bring about increased use of potassium and other nutrients in the Midwest will be listed.

1935-39

High potash requirement of muck soils had received considerable emphasis by this time in Michigan, Ohio, and Indiana.

A symposium on availability of potassium in soils was organized for the 1935 annual meeting of the American Society of Agronomy. It was later stated that there was little chance of stimulating the release of potassium from Illinois soils, when the available potassium had been cropped to a low level. There was a marked expansion in soil-testing services in several states during this period.

Eckstein, Bruno, and Turrentine published a book "Potash Deficiency Symptoms." This as well as other events helped to direct increased attention to plant diagnosis as a means of evaluating nutrient status. Interest in tissue testing continued to mount.

A changing philosophy in several states was reflected in a publication released from Ohio entitled "Our Heritage—the Soil." This emphasized the importance of maintaining productivity of soils.

"Potassium in Plant Metabolism," a paper dealing with the roles of potassium in plant growth, was published.

A motion picture "New Soils from Old" was produced in Illinois.

The Middle West Soil Improvement Committee was organized to encourage proper use of fertilizers in the Midwest. The committee inaugurated an information service to newspapers.

Midwest agronomists met to discuss fertilizer grades most suitable for agronomic needs and still feasible from the manufacturing standpoint; 2-16-6 was not recommended after 1940.

A reduction of frost injury of potato vines by high-potash fertilizers was reported at Mancelona, Michigan.

(*Turn to page* 32)

Potash in the Western States

By M. E. McCollam, Western States Manager

THE advance of potash usage in the Western States has been very dependent upon research. Many of our Western soils have been initially well supplied with potash, and our agriculture has not drawn upon the resources of our soils for as great a period of time as in other sections of the country. The acceptance of this premise minimized the interest of research workers in such potassium studies as might be of greatest positive value for creating more potash usage.

The Institute early realized that increased potash use in the West depended very largely upon the proof of need through research. Through the means of research grants and fellowships an active program of cooperative research with the land-grant colleges and experiment stations has been carried on. Over the past 20 years these grants and fellowships have been placed each year in at least three western states and at times in five states.

In California, Institute funds have been placed in the form of grants-in-aid for research carried on cooperatively with various departments of the University and Experiment Station. Earliest grants were made to the Departments of Plant Nutrition and Pomology.

One of the first accomplishments with this research arrangement was the completion of an extensive appraisal of the available potassium in California soils by the Neubauer method of soil testing. Information of this nature had not previously been available and seemed very basic to further potassium research in the field. Soil samples from 294 locations at two or more depths, and representing 130 California soil types, were taken and subjected to the Neubauer test. About 30 per cent of these soils were low to very low by the Neubauer standards. This project served to focus attention on the fact that potassium problems might well exist in California to a greater extent than was formerly judged to be the case.

In following the results of potassium soil tests with research in the field to obtain crop response to potassium, a number of cases where the expected response did not materialize were encountered. This led to a proposal for further research to obtain a diagnostic tool in potassium studies which would be more reliable than the soil test for potassium, at least where certain crops were concerned. At this point the research grants made to these same Departments of the University of California were directed to the chemical analysis of leaves as an indicator of the potassium status of the plant.

The accomplishments made through leaf analysis in explaining the problems which arose in field research, in locating potassium-deficient areas, and in developing a reliable aid in making fertilizer recommendations have been quite rewarding, and a research grant is being continued in the Pomology Department for a still greater development of leaf analysis in potassium research.

Research grants have also been made to the Department of Soils and Plant Nutrition on the Riverside campus of the University of California. These funds have been under the supervision of Dr. Homer Chapman and were first directed toward a study of the diagnostic value of leaf analysis with citrus crops. This research has led to the establishment of critical and response

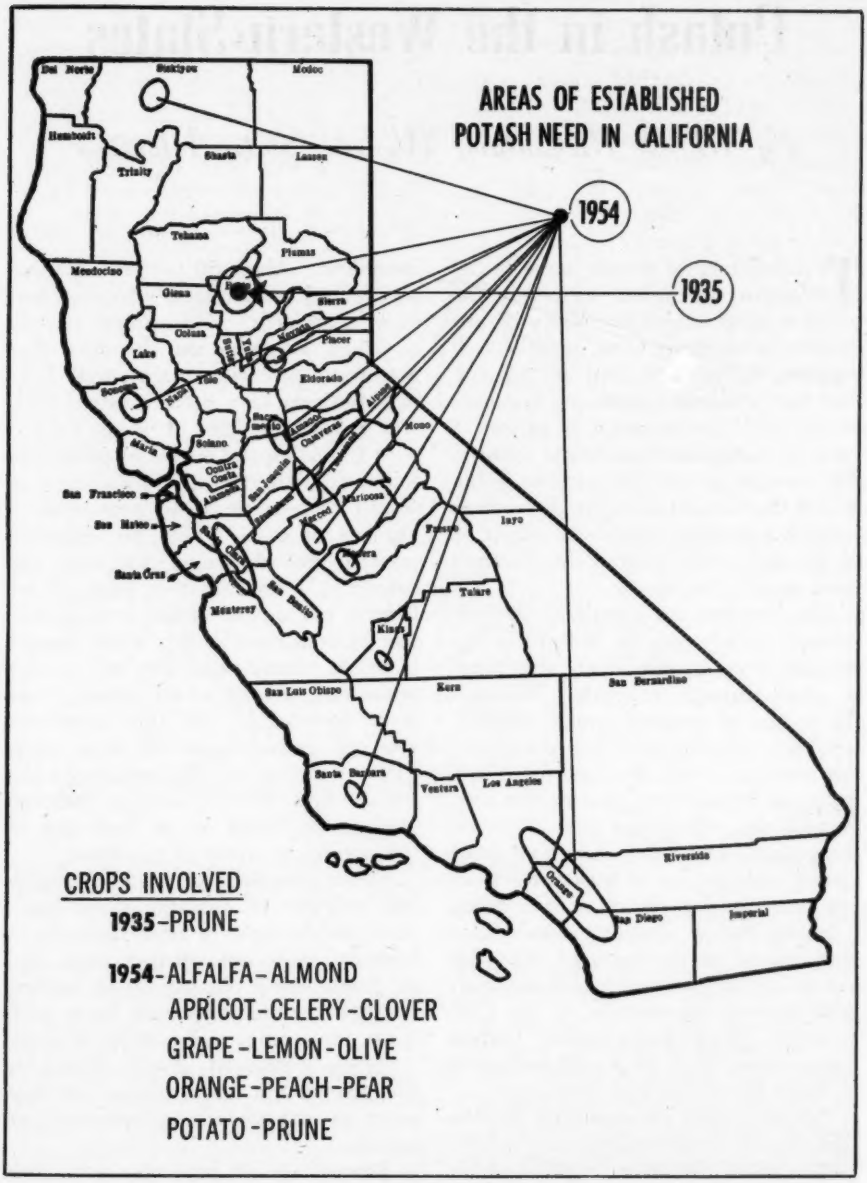

Fig 1.

levels of potassium in citrus leaves and to studies which indicate that potassium shortage may be contributing to quality troubles in California citrus crops. Currently, a research grant to this Department is being used for a study of the factors affecting potassium absorption by citrus trees.

Potash Institute fellowship grants have been in effect continuously at Washington State College. Several potash fellows worked on a survey of available potassium in Washington soils by the Neubauer method. Many

of the soil types west of the Cascade Mountains were found to be low in potassium by this standard. Leaf analysis studies were also included in later research in this State conducted under potash fellowships.

In earlier years grants-in-aids for research at the Western Washington Experiment Station were used for expanding fertilizer work on vegetable crops, including ratio, rate, and placement studies. This particular program of field research was carried on for about 10 years and won widespread approval from growers and processors for its great practical value. During this same period some of the Potash Institute funds were used to equip a laboratory at the Western Washington Experiment Station for leaf analysis research and enabled basic work to be done on leaf-sampling technique and nutrient levels in canning pea and potato plants. Currently a re-

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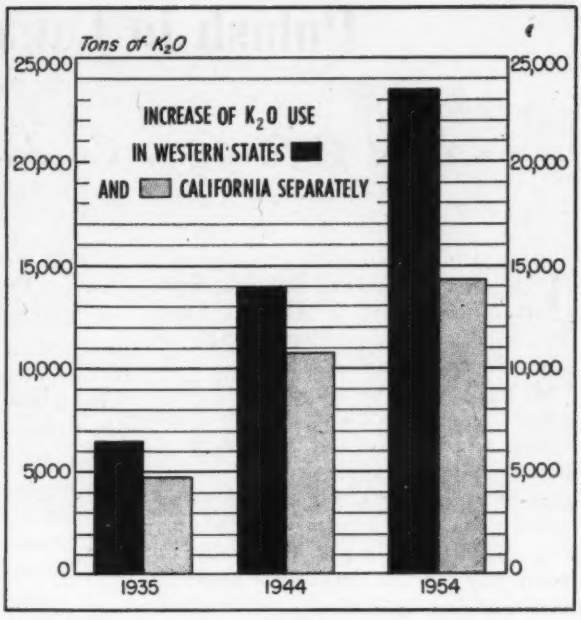

Fig. 2

Fig. 3. Peach tree exhibiting severe potash deficiency. Delhi, California.

Potash in Canada

By R. P. Pennington, Canadian Manager

THE first 20 years of the American Potash Institute in Canada have been a period of great changes both in amounts and kinds of fertilizer used and type of crops produced. The farmer of Canada today has put himself in a better economic position than he was 20 years ago through the formation of many marketing and growers associations. The farmer of Canada today is alert and eager and ready to adopt any practice that might improve his cropping procedure and over-all income. Agricultural experiment stations and research personnel are constantly seeking means of putting science to work more effectively to improve his situation. These new developments are being brought to the farmer by a very capable extension service which is utilizing demonstrations, meetings, and personal contacts as well as radio and television.

The Potash Institute congratulates the people in Canada who made this tremendous development possible. It hopes that in some small way it was able to encourage and aid in some of this achievement.

The chief objective of the Canadian Office of the Institute, when established in 1935, was to increase the consumption of potash in so far as good farm practice justified its use. In order to achieve this objective, it has always been the policy to work closely and cooperatively with Government and agricultural college authorities. In line with this thesis and because research is basic, over the past 20 years several potash fellowships have been established at various research centers in eastern Canada.

Potash Fellowships

It will not be possible to cover in detail all of the work that has been carried on and supported in part by these fellowships. They have been set up at nine institutions as follows:

1. Ontario Agricultural College, Guelph, Ontario.
2. Macdonald College, Quebec.
3. Laval University, Quebec City.
4. Institut Agricole D'Oka, La Trappe, Quebec.
5. L'Ecole Superieure D'Agriculture, Ste-Anne-de-la-Pocatiere, P. Q.
6. Nova Scotia Agricultural College, Truro, Nova Scotia.
7. Kemptville Agricultural School, Kemptville, Ontario.
8. Horticultural Experiment Station, Vineland, Ontario.
9. Dominion Experiment Station, Kentville, Nova Scotia.

Once a fellowship has been established at an institution, responsibility for the research and the development of the fellowship has been entirely that of the supervising officials at the experiment station concerned. The first step in inaugurating any such agreement is to establish certain broad objectives. Once these objectives have been established, the actual method of attack has been left to the discretion of the research man who is actually doing the work. The majority of the investigations supported by the Institute in Canada emphasize the development and calibration of soil- and tissue-testing procedures as well as crop response-soil test calibration. At present, fellowships are maintained at the Ontario Agricultural College in Guelph

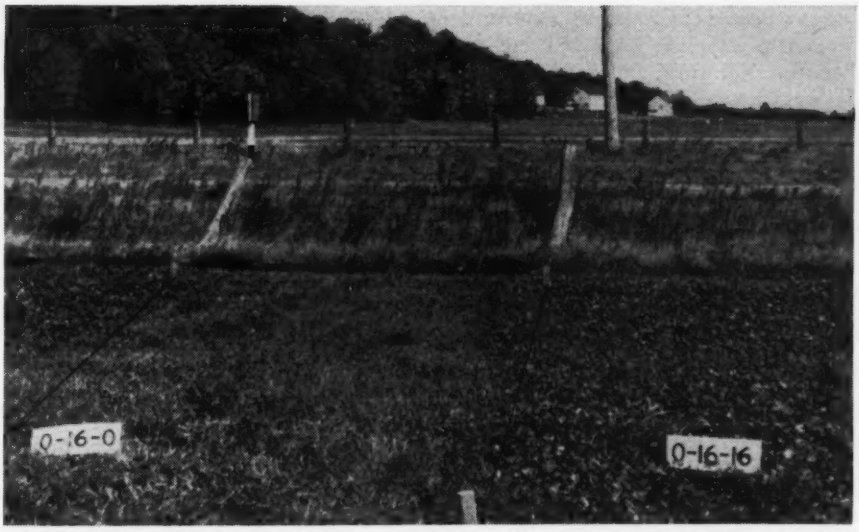

Fig. 1. This shows the poor percentage of ladino clover on the 0-16-0 plot compared to the 0-16-16. These experimental plots were on a farm at St. Nicolas, Quebec, and had been fertilized with a 500-lb. application of the respective treatments in both 1950 and 1951.

and Macdonald College in Quebec. Some idea of the scope of the fellowships sponsored by the Institute will be gleaned from the following description of the work carried out and the results that have been of permanent benefit to Canadian agriculture.

Fellowship at the Horticultural Experiment Station, Vineland, Ontario: Prior to the introduction of soil testing, the value of mineral fertilization to the fruit crops in the Niagara District was not realized. About this time, however, Director E. F. Palmer and his associates became suspicious that some of the trouble being experienced in both their apple seedling orchard and peach orchard might be due to potash deficiency rather than to spray injury. Moderate applications of potash were given these apple seedlings, and their recovery was remarkable.

Since these potash-deficiency symptoms seemed to be so evident in the Experiment Station orchards, there was some curiosity as to how widespread this deficiency might be throughout the Niagara District. For the purpose of making a systematic study of nutritional levels of the orchard soils in this and other areas, a fellowship was established in 1936. During the first year more than 200 farms were surveyed for nutritional levels, and fertilizer recommendations were made for each of the growers. It was found that potassium was generally lacking in the peach-growing soils of the District, and from that point on a more active program was undertaken for correcting this situation.

Under the same fellowship, subsequently, other areas were similarly surveyed. In 1937 all of the orchard sections of the southern portion of the Province were investigated for potash deficiency; in 1938 the area adjacent to Lake Huron was surveyed; and in 1939 the area below the escarpment from Hamilton to Collingwood. Thus, in a period of four years most of the important orchard sections of the Province were surveyed for potash deficiency, and recommendations were made for its use when soil tests or foliage symptoms indicated the need.

Fellowship at the Ontario Agricultural College, Guelph, Ontario: The research which has been supported at the Ontario Agricultural College has

always been of a practical nature, designed to establish a closer correlation between soil tests and crop response. It was inaugurated in 1937 when it was felt that soil testing, which had recently been introduced in Canada, should be given a very careful study before being generally adopted throughout the country. This was wise because soil and climatic conditions and crop practices differ widely from the portions of United States where these quick soil tests originated.

The investigations showed that the conventional phosphate test, as designed by Dr. Thornton, was not suitable for the high-lime soils in this part of the country. A modification of it was worked out and now has been accepted universally for the high-lime soils. From this work, an excellent soil-testing service was provided for innumerable farmers in the region. This activity did more to inspire confidence in the short soil-testing methods than anything else, and use of them has grown rapidly since the work was published.

Later, investigations were conducted on the effects of soil type and fertilizer treatments on the yield and chemical composition of certain forage crops and also on some fertility requirements on two soils from Renfrew county as indicated by chemical and greenhouse tests. The current project is attempting to solve some of the problems associated with muck soils, particularly those of the Holland Marsh area north of Toronto.

It is felt that this type of research will show the farmer how he can use fertilizer as a tool to increase his crop yield and decrease his unit cost of production.

Fellowship at Kentville, Nova Scotia: This fellowship was established in 1937 to provide for the survey of the extensive apple-growing district of the Annapolis Valley. A thoroughly modern laboratory was provided by the Dominion Government for carrying out these tests at the Experimental Station at Kentville, Nova Scotia, and most of the orchards were surveyed sometime during the three years of the operation of this fellowship. Many of the orchards were found to be relatively high in potash, but a substantial number were found to be dangerously low and a good deal was done in that District to correlate potash-deficiency symptoms in the leaf with potash tests of the soil. During the last year of this fellowship it was arranged to cover some of the better farming sections of Nova Scotia, and numerous demonstrations were laid down where the mineral levels were found to be unusually low. Altogether, it is believed that this research did much to consolidate the progress and create a demand for soil-testing service by the farmers throughout that Province.

Fellowship at L'Ecole Superieure d'Agriculture, Ste-Anne-de-la-Pocatiere, P. Q.: Many of the Quebec soils, particularly those found in the lower portions of the Province, have quite peculiar characteristics and it was not felt advisable to recommend the use of short soil-testing methods in these districts until their usefulness was established by experience. Therefore, in 1938, a fellowship was established in the Falculte d'Agriculture of L'Ecole Superieure d'Agriculture, at Ste-Anne-de-la-Pocatiere, which lasted for four years. Most of the lower areas adjoining the St. Lawrence River were investigated, and it was felt that some modification should be made in the technique and chemical solutions to suit the highly acid soils of that area. During the term of the fellowship, a new soil-testing procedure which is termed the Pilote Soil Test was devised. This is put up in a case suitable for "agronomes" or soil specialists, to carry around with them if necessary.

Fellowship at the Kemptville Agricultural School, Kemptville, Ontario: A fellowship was established at the Kemptville Agricultural School during the fall of 1939. This agricultural institution is situated in eastern On-

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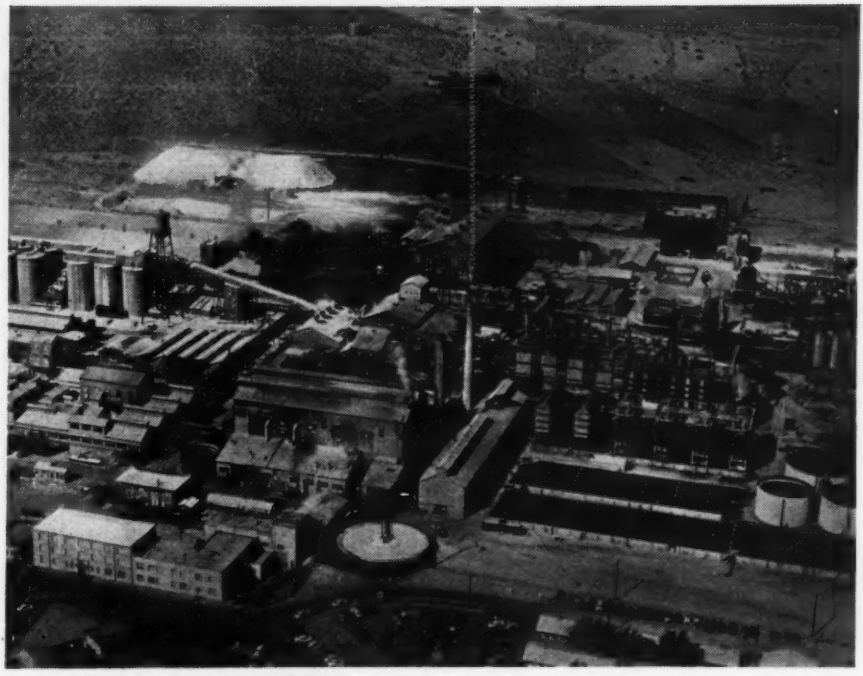
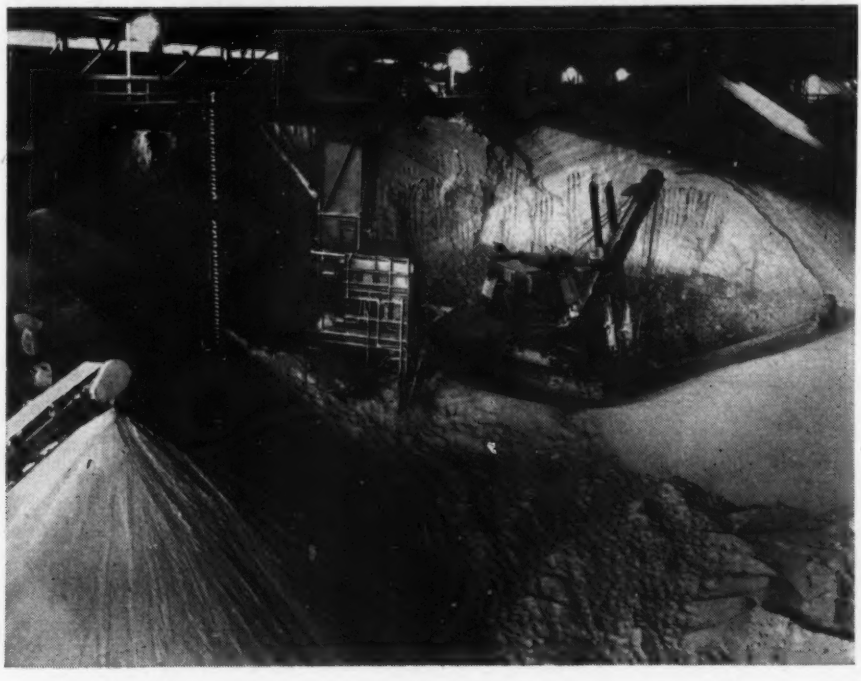


Above: View of refinery, Trona, Calif.

American Potash & Chemical Corp.

Below: Potash in storage warehouse.



Above: View of refinery, Carlsbad, N. M.

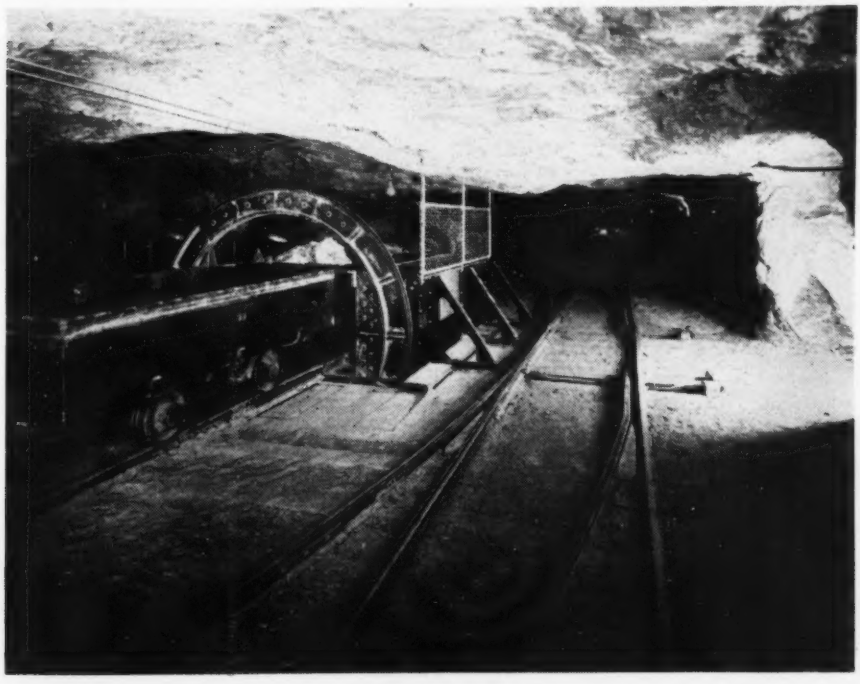
Duval Sulphur & Potash Co.

Below: Interior view in refinery.

Above: Refinery and minesite, Carlsbad, N. M.

Potash Company of America

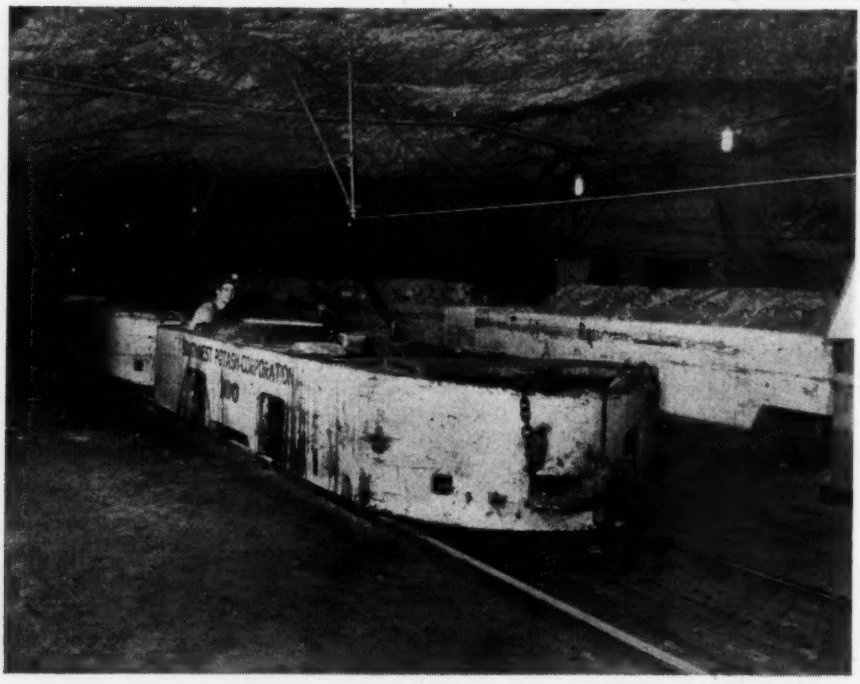
Below: Car-dumping underground.



Above: View of refinery, Carlsbad, N. M.

Southwest Potash Corporation

Below: Transporting ore in mine.



Above: View of refinery, Carlsbad, N. M.

United States Potash Company

Below: "Continuous miner" cutting ore.

Potash in the Midwest

(From page 20)

Results of demonstrations on small grain in Wisconsin showed profitable responses to fertilization. Widespread demonstrational programs on corn and forage have since been carried out.

Outstanding responses of corn and wheat to potash applications were obtained on Hopkins "Poorland Farm," Salem, Illinois, where only limestone and phosphates had been used. Results paralleled trends on long-time experiments.

Potash sidedressed on corn in June, after deficiency symptoms appeared on high-lime soils in Iowa and on gray prairie soils in Illinois, produced profitable increases. Earlier applications of potash at planting or before were recommended.

The TVA phosphate demonstration program helped extend fertilizer usage into new areas, as in Minnesota.

Hybrid corn began to expand rapidly and by 1943 almost 100 per cent of the acreage was in hybrids. Breeding for adaptation to higher fertility levels raised yield potentials and fertilizer requirements not only for corn but also other crops.

1940-44

Heavy fertilization experiments on corn with emphasis on plow-under methods were conducted in Indiana and results were correlated with soil tests, tissue tests, and total nutrient consumption. Purdue Bul. No. 482 "How to Fertilize Corn Effectively in Indiana" was released. This did much to encourage interest in the use of diagnostic techniques and adequate quantities of plant nutrients in other states.

A book including color illustrations "Hunger Signs in Crops" was released by the American Society of Agronomy and the National Fertilizer Association.

Improved soil test for potassium was adapted in Illinois. This and the phosphorus test were based on extensive calibration studies on 23 experimental fields.

First complete county soil-testing laboratory in Illinois was organized in Whiteside County. There are now 81 county and 31 commercial laboratories in Illinois. In 1954 it was reported that 517,000 soils were tested representing a total of 1,795,000 acres.

The January 1943 edition of Soil Science was devoted to potassium. Twelve papers presented in the Division of Fertilizer Chemistry of the American Chemical Society were included.

Outstanding response of peaches to potash application was demonstrated in orchard at Hartford, Michigan. Subsequent trials indicated many orchards need potassium as well as nitrogen.

Responses of corn to potassium as well as to phosphorus in northeast Iowa demonstrations helped lead to experiments confirming these indications.

First nitrogen fixation plant in Midwest began operation—Spencer Chemical Company, Pittsburg, Kansas. Since then, increased tonnages of nitrogen compounds, as anhydrous ammonia, ammonium nitrate, urea, solutions, etc., have increased production potentials on many farms.

Rapid increase in soybean acreage had begun. Soybeans replaced oats and other crops in many rotations. This crop depletes soils of minerals if unfertilized.

World War II brought increased demands for food, fibre, and oil crops. More fertilizer helped total production and farm efficiency.

1945-49

Iowa initiated present soil-testing program of two regional laboratories. About this time and since, the soil-

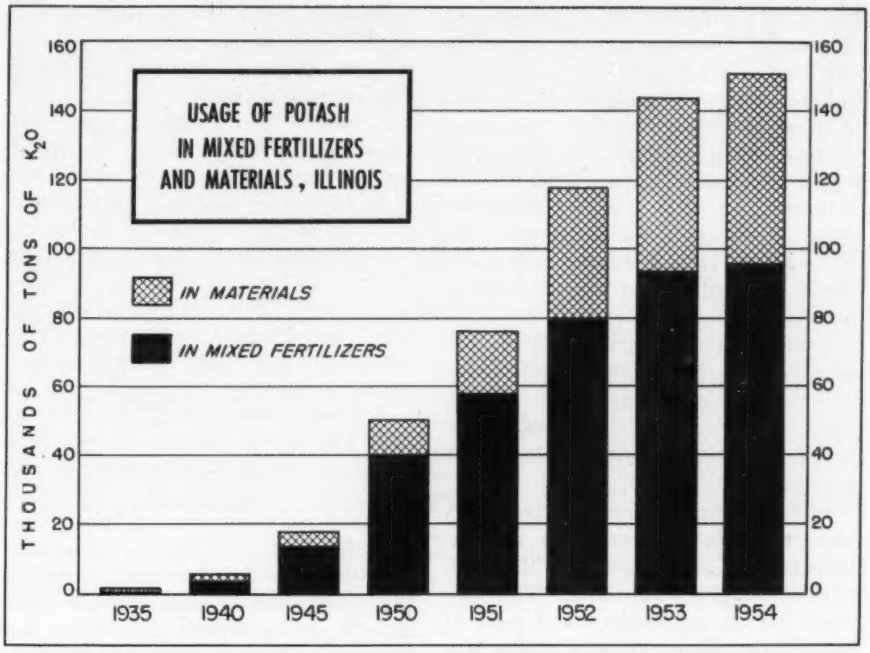


Fig. 6. The use of potash as a material is increasing rapidly in Illinois.

testing programs in most states have been developed and improved. For example, Kentucky now has 107 county laboratories, Missouri 100, Kansas 58, and Michigan 45.

A practical soil core sampling tube was developed to obtain undisturbed soil profiles 15 inches deep, for comparative studies. When a chalk suspension is dropped on cut soil surface at several levels, chalk remains on surface where soil is compact and water penetration is slow. Compact soil zones mean poor aeration and slow drainage (Figure 7).

Dipicrylamine filter paper test for potassium in plant tissues developed at Penn State. Subsequent modifications were made in Illinois and Indiana.

Limestone tonnage increased to a peak, but usage has since declined.

Balanced farming program well under way in Missouri.

A book—"Diagnostic Techniques for Soils and Crops" was published by American Potash Institute. Second edition of the book "Hunger Signs in Crops" released.

Green Pastures program initiated in Kentucky.

Modified Purdue potash tissue test adapted for use on peach leaves, and correlated with leaf analyses in Michigan. This was first modified for peaches in 1936.

Peaches from potash-starved trees (Lacota, Michigan) shown to have higher respiration rate than those from trees with adequate K. Correlated with rapid breakdown in storage of low-K peaches.

Leaf analyses by spectrographic techniques offered as a service to Michigan orchardists.

1950-54

Greatly increased supplies and use of nitrogen increased need for phosphorus and potassium.

Pacemaker Club for corn and Sure-

fire alfalfa program were initiated in Wisconsin. Fertilizer prescriptions based on soil tests were emphasized.

Benefits from phosphorus and potassium on longevity of alfalfa were shown again in trials in several states including Kentucky, Wisconsin, and Illinois. Starvation of alfalfa results in dwindling growth and reduced stands. In 1952, 36 per cent more alfalfa was reported as compared to 1941-50 average for Midwest.

Root studies on corn, wheat, soybeans, clovers, and alfalfa, grown under different fertility conditions in Illinois, show that lack of limestone, phosphorus, or potassium restricts root growth as well as top growth.

Bulk handling of mixed fertilizers and materials for corrective applications became more popular by this time after starting around 1945. This fostered heavier applications and reduced hand labor. Many Midwest plants now supply bulk fertilizers and spreading services.

"Guide to the Management of Illinois Soils" released.

Missouri began interpreting soil tests on the basis of total exchange capacity in order to better take soil differences into consideration.

A book—"Care and Feeding of Garden Plants"—was published by American Society of Horticultural Science and National Fertilizer Association showing many deficiency symptoms of truck crops, small fruits, trees and flowers.

A booklet "Potash-Deficiency Symptoms" including 26 color plates on various crops was released by the American Potash Institute.

A paper "Potassium in Plant Nutrition" by Michigan authorities was published in Advances in Agronomy, Volume VI.

Potash Subcommittee of North Central Regional Technical Committee N C 16 formed. A prime purpose of this group was to further relate plant growth and nutrient uptake to soil characteristics with particular emphasis on potassium.

The North Central Farm Management Research Committee, Subcommittee on Economics of Fertilizer Use,

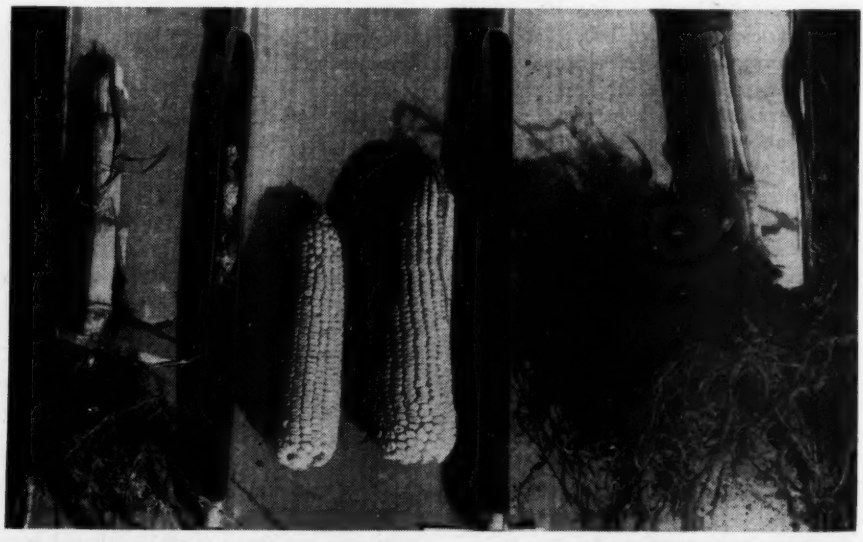


Fig. 7. Effect of red clover pasture (left) and three years of alfalfa (right) on soil compaction. Note compacted soil to plow depth (left) and good soil porosity due to the deep roots of alfalfa (right). The corn roots at left were rotted and many plants lodged. Dr. Hoffer developed the lime-water method as a qualitative measure of compaction.

Fig. 8. Dr. Hoffer discussing with farmers and representatives of Soil Conservation districts the effect of potassium deficiency on the efficiency of the sap-conducting tissues in cornstalks. He used methylene blue to stain the functioning tissues. The blue stain was distributed throughout the healthy plants, but not in the deficient plants. The conducting tissues in the potash-starved plants were badly clogged and functioning poorly.

published Wis. Bul. No. 508 "Profitable Use of Fertilizer in the Midwest."

The intensified efforts in research and extension have been of first importance in pointing out plant-nutrient requirements. The development in the college teaching programs has likewise been influential in that more fully informed vocational teachers, county agents, and other agricultural workers are being graduated from the colleges. The effort of industry in making adequate supplies available and supplying the fertilizers better fitted to crop needs has been, of course, the final link in the chain. More and more of the industry are employing agronomists to assist in finding what the needs are and to assist growers in the choice of plant nutrients.

Last but not least it must be recognized that the improvement of the farmer's purchasing power has been an important factor in the increased use of potassium as well as other plant nutrients.

Activities of the Institute

In the objective to encourage research and education in the proper use of potassium as well as other plant nutrients, it has been extremely important to consider all nutrients. The amount of potassium which is profitable today may be considerably below that which will be profitable 10 years from now as other management practices are improved. The interests of the Institute are basically those of encouraging a continuing efficient agricultural production.

Fellowships and Research Grants: During the last 20 years the Institute has provided a total of over $200,000 in research fellowships in Midwest colleges because research is recognized as a basic necessity. The funds contributed to a given institution for a certain project pay only a portion of the cost of the project, as in most instances the college contributes much in the way of funds, personnel, and equipment. Research under these funds is entirely under the supervision of the particular institution involved.

While the data obtained are important, an equally important aspect is the fact that men are being trained for

future participation in agricultural work. More than 100 graduate students have received aid on the Institute fellowships in the Midwest. While space does not permit listing these men and present location, they are now occupying positions of responsibility in colleges, U. S. D. A., or industry all over North America.

The main objective of the research projects undertaken is to solve concrete potassium problems with due regard to the other essential nutrients and management practices. These problems may relate to local, regional, or nation-wide aspects but basically have to do with the behavior of potassium in soils and crops, and actual requirements.

The general subjects covered might be grouped as follows:

1. Methods for analyzing soils and correlation with crop responses.
2. Methods for analyzing plants and correlation with crop responses.
3. Potassium fixation and availability in soils.
4. Behavior of potassium in plants with respect to other ions.
5. Function of potassium in plants.
6. Potassium fertilization of crops including variety-fertility studies and time and methods of application.

The importance of such studies in encouraging proper and adequate use of potassium is well recognized, and these investigations have played a part in the rapid expansion in the use of potassium in the Midwest. However, there is full realization that the need for further studies is tremendous.

Diagnostic Techniques: Diagnostic studies on soils and plants are of prime importance in encouraging proper use of plant nutrients. A trend toward individual field-by-field diagnoses has become necessary because of man-made variations within soil types. General fertilizer recommendations on the soil type basis may not solve many individual fertilizer problems which change gradually. The rapidly expanding soil-testing program and the mounting interest in tissue testing in the Midwest are in recognition of this fact. These tests fit in well with confirmation of deficiency symptoms. The Institute has assisted by encouraging and supporting research investigations on the use of these diagnostic tools. In the neighborhood of 50 graduate theses on Institute-supported projects have been written on this general subject in the Midwest.

Institute personnel have participated in demonstrations and in trouble shooting with chemical and physical soil tests and tissue tests. In addition they have written numerous articles on the development and use of diagnostic techniques. The pioneer work by Dr. G. N. Hoffer in this field has helped to lay new tools in the hands of the field agricultural workers (Figure 8).

Assistance has been given in developing many of the tests now in use. In addition direct help and encouragement have been given to others to utilize such techniques. For example the Institute staff has helped in assembling tissue test kits and providing instructions for those county agents in Missouri who are interested. The sound reasoning and analytical plant physiological approach have been of assistance to a wide range of individuals including farmers, county agricultural workers, extension men, research investigators, and industry personnel.

Demonstrations: The Midwest program has been maintained on the basis of the cooperating agency taking the lead in the planning and execution of the demonstrations. These have been primarily with the colleges, but cooperation has been given the Soil Conservation Service and other Government agencies.

In the period 1935-1944 more than 4,000 cooperative demonstrations were carried out. These were on a variety of crops—corn, small grain, pasture and hay, orchards, sugar beets, potatoes, tomatoes, and truck crops.

In the past 10-year period there has been a continued interest in this program. At present in Indiana there are 33 pasture renovation demonstrations now under way in conjunction with TVA source of phosphate trials. Some 40 fertilization demonstrations on legumes are in progress in Kentucky. In Wisconsin there are some 40 demonstrations on alfalfa, pasture, and corn. In Missouri 24 alfalfa demonstration plots are being continued. In addition there are several more limited types of demonstrations underway.

Cooperative Work: There are many types of activities which might be classed under cooperative work. The Institute staff has assisted in photographing crop responses to plant nutrients and deficiency symptoms where such assistance was desired. Oftentimes the agricultural workers may not have the time or equipment to take suitable photographs. Once the photographs are taken, however, they have been extremely useful in subsequent write-ups of the experimental or demonstrational work. This photography has been both in color and black and white. Many of these color photographs are now appearing on the cover page of Better Crops With Plant Food. In addition, considerable assistance has been given in making motion pictures in certain states.

Eight color films are available for loan on a national basis. The Visual Aid Service, University Extension, University of Illinois, Champaign, serves as a distributor of these films in the Midwest.

Help is given in taking data in field trials. An example is the assistance rendered in making root studies on wheat and alfalfa in certain of the fertility plots in southern Illinois (Figure 9).

Other efforts include support to send 4-H Club members to the National meetings. Assistance has been given also for staff members and undergraduate and graduate students to attend scientific meetings or tours.

Cooperation with Industry: By the nature of the objectives of the Institute most of the cooperation is with research and educational groups in colleges and Government. However, considerable

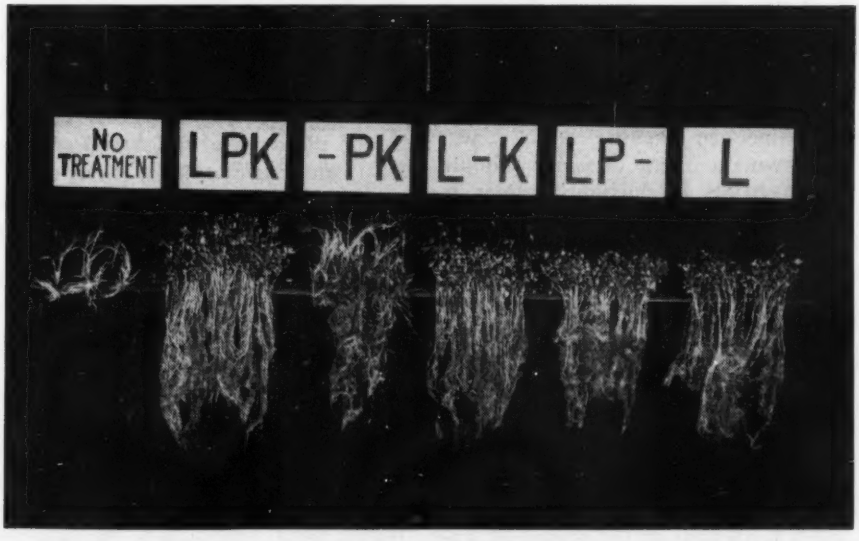


Fig. 9. Alfalfa made a vigorous growth in the first three months in certain residual treatments. Omission of one or more of the nutrients restricted growth. Brownstown Soil Experiment Field, Brownstown, Illinois. (Photo by H. L. Garrard).

contact has been maintained with industry, much of it through trade organizations. When the Middle West Soil Improvement Committee was first formed, the Midwest Manager cooperated closely and was on the Board of Directors. In addition, contributions were made for cooperative demonstration work.

Institute personnel are continually being invited to participate in industry meetings and to serve on committees such as the Plant Food Research Committee. Perhaps one of the major contributing reasons for this is that nutrition problems are considered on a broad basis.

The Midwest staff wishes to express appreciation for the excellent cooperation of the agricultural workers and industry over the years. Progress in the use of potash in the Midwest would not have been possible without the assistance of the colleges and experiment stations, other agricultural agencies, and the trade.

The American Potash Institute

(From page 9)

area took nearly five times as much potash, or 1,955,000 tons K_2O. This is shown on the chart, the rise being unbroken since 1939, except for 1949 when a strike in the Carlsbad, New Mexico, producing area reduced output.

In 1935 less than half the potash used in North America was of American origin, and it was not until 1938 that American deliveries pulled ahead of European potash. With the cutting off of European imports due to the war, the American potash industry was faced with a major decision. Should it expand its production facilities to fill the gap left by the cessation of imports, or should it conserve its capital to enable it to meet the competition likely upon the resumption of imports after the war? This decision was the more difficult to make in the face of lack of any tariff protection, and the fact that the funds involved would all be private capital. The work of the Institute was just getting under full momentum, but already there were indications of greatly increased future needs for potash on the continent. The new American potash industry therefore decided to plan for an expanding potash market in the future, and undertook to increase greatly its production capacity as fast as war conditions would permit. The record shows that this faith in the future was fully justified. A shortsighted policy of standing pat would have resulted in a serious shortage of potash in North American agriculture, interfering with the war effort, with consequent losses to farmers and the general public.

It is felt whatever success has attended the work of the American Potash Institute is due to the policy of the American potash producers that the use of potash should be on a basis sound and profitable to the farmer. The producers realized that only in this way could their business continue to grow and prosper. This policy was laid down in establishing the Institute and has consistently been followed ever since. In this way the confidence of the official agricultural advisory groups was gained, and only by following such a course could the Institute have obtained their cooperation, so essential in the success of such a large undertaking.

Potash in the South

(From page 12)

duction and the difficulty of maintaining stands. A tour to study causes of the trouble revealed that while a number of factors were responsible, the one most responsible was inadequate annual maintenance fertilizer.

An extensive fertilizer test demonstration program has been conducted for some years on about 100 alfalfa fields in the major alfalfa-producing counties of Tennessee. This effort was a cooperative one among the Pacific Coast Borax Company, the American Potash Institute, and the Tennessee agronomists and county agents. The demonstrations involved the use of adequate amounts of fertilizer on one acre of a field while the contrasting area for comparison consisted of the farmer's regular treatment of the rest of the field.

Results of these demonstrations have been rather spectacular and have done much to prove the need for an annual application of fertilizers such as 0-12-12, 0-10-20, 0-9-27, all containing borax. They have also shown farmers that alfalfa can be grown successfully if proper fertilizer and managerial practices are followed. As a result, alfalfa acreage is once again on the increase in Tennessee. Figures 7 and 8 show contrasts on two fields on which demonstrations were conducted.

Contests: Over the years contests have been very useful in bringing out production possibilities. Many farmers in the South did not realize that the ordinary farmer could produce 100 bushels of corn, or three bales of cotton, or a ton of peanuts, or a fine pasture, until he saw his neighbor enter a con-

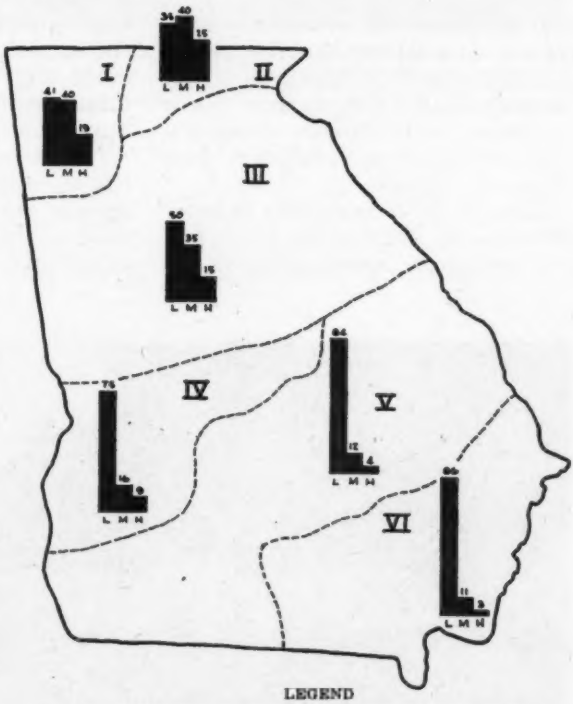


Fig. 4. A recent Georgia publication reported on a summary of soil tests run by the University of Georgia Soil Testing Service. These summaries are being prepared by many states and show general fertility levels in soils over the South. Numbers above bars are per cent of tested soils represented in each category (L = low, M = medium, H = high amount of available K_2O in soils).

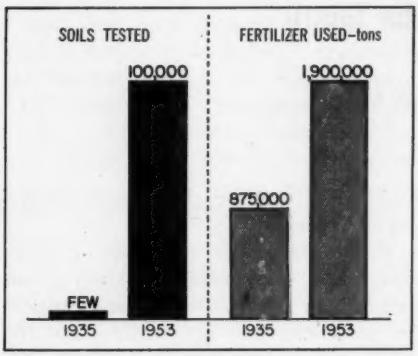


Fig. 5. In North Carolina 20 years have seen soil testing come into its own; at the same time fertilizer consumption has doubled. There is no question but that soil testing leads to more efficient fertilizer usage.

test and do it. It is true that some contests do not prove that it is always practical to produce three bales of cotton per acre, but they do show that it is possible, and follow-up demonstrations and educational programs show the practical limits.

Through the 20 years since its establishment, the Institute has had a part in a great many contests either as sole sponsor or as one of several sponsors. These contests have been conducted by either extension service workers or vocational teachers, who do a splendid job of publicizing and conducting the contest while the Institute's part has been one of sponsoring and financing.

There is no question but that these contests serve to illustrate the possibilities of good practices, including good fertilizer usage. Also, they are a stimulation to contestants, particularly young 4-H Club and FFA boys who are the future farm leaders. Production contests sponsored by the Institute have dealt with many crops, including peanuts, corn, cotton, soybeans, pastures, sweet potatoes, and general vegetables. At present a Southwide contest in Efficient Cotton Production is being sponsored by the Institute and conducted by the Cotton Educational Committee of Vocational Agriculture.

Industry Cooperation: In its cooperative work with State and Federal agencies the Institute's activities are of value to the entire fertilizer industry, even though it constitutes only a seg-

Fig. 6. Twenty years ago soil-testing services in the South were just in the thought stage. The Potash Institute's research grant with Dr. L. C. Olson at Experiment, Georgia, helped to develop soil-testing methods. Today Georgia is proud of its fleet of six mobile soil-testing laboratories.

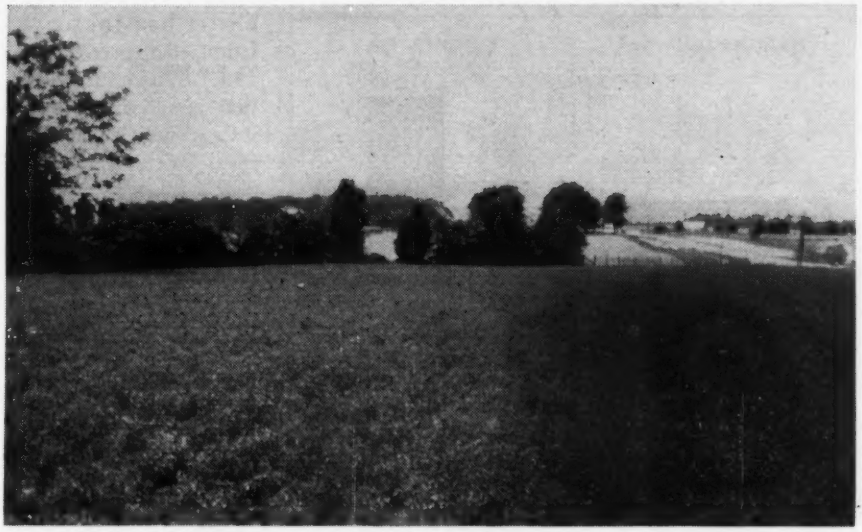


Fig. 7. The Potash Institute over 20 years has cooperated in thousands of demonstrations throughout the South. A recent demonstration program in Tennessee (described in February 1954 issue of "Better Crops") showed that hay yields were increased one ton per acre on the treated area (right in the picture above) which received 300 lbs. muriate of potash and 20 lbs. fertilizer borate per acre.

ment of it. The fellowship program, for example, has always included many projects that deal with basic or fundamental studies of soil and plant nutrition, and as such research ultimately results in a sounder agriculture, both farmer and industry are benefited.

Both the demonstration and contest

Fig. 8. A cooperative program on J. B. Strawn's farm in Coffee County, Tennessee, shows the contrast in hay yields in properly treated alfalfa and that receiving inadequate amounts of fertilizer.

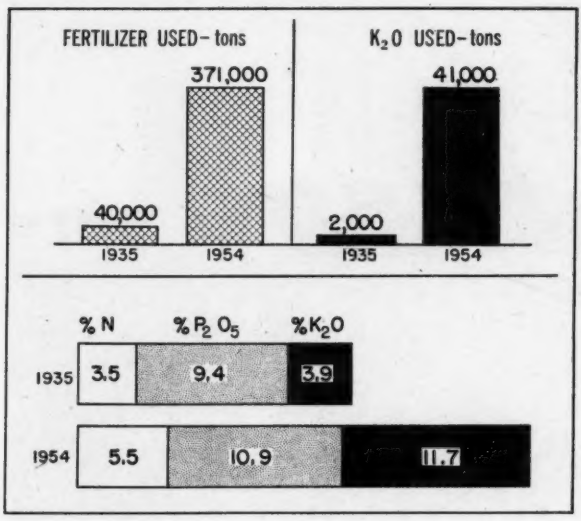


Fig. 9. In Arkansas many changes in fertilizer usage have occurred in the past 20 years. Demonstrations, soil tests, and extension programs have carried research results to farmers. The results: Nine times as much fertilizer used, 20 times as much potash, and a big change in the average content of plant nutrients in mixed fertilizers.

activities of the Institute are ordinarily industry-wide in benefit. Contests such as "Efficient Cotton Production," "Sweet Potato Production," "4-H Corn Contests," etc., are certainly not limited in scope to potash. They aim to serve agriculture as a whole and hence the fertilizer industry. As agricultural progress has been made in the past 20 years, consumption of all fertilizers, including potash, has increased. Figure 9 points out the growth of the industry in Arkansas, a State using only 40,000 tons of fertilizer in 1935. Note that the average plant-food content of fertilizers has increased from 16.8 per cent to 28.1. This figure is one that is often not taken into account in figuring fertilizer costs per ton.

Summary

A glimpse back at the past 20 years reveals a tremendous change in the agriculture of the South. This has been accompanied by an increase in the consumption of fertilizers, including potash, far beyond expectations. Much of the credit for this progress is due to the farsighted research and educational programs of the state and Government agricultural leaders. Also, the sincerity of purpose, the liberality of funds, and the farsighted policies of the Member Companies from the potash industry have made it possible for their American Potash Institute to work very closely with these agencies through fellowships, contests, demonstrations, motion pictures, and publications.

Through these programs the Institute has worked, together with members of the entire industry, in selling the program of sound fertilization and in promoting a better standard of living for the farmer.

Potash in the Western States

(From page 23)

search grant is being used at this Station to study the effects of potassium and other nutrient elements on the yield, quality, and disease resistance of the strawberry and raspberry. This study involves the Departments of Soils, Food Processing, and Plant Pathology.

In the State of Oregon, the Potash Institute has maintained fellowship

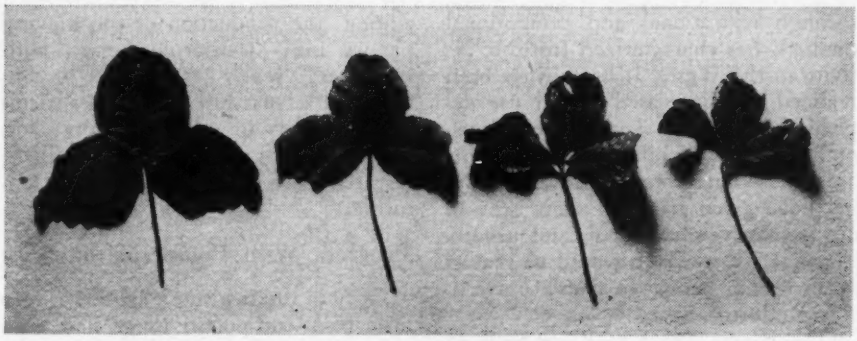


Fig. 4. Potash deficiency on alsike clover in Western Washington. Left: Normal leaf. Right: Progressive stages of K-deficiency.

funds continuously with the Soils Department of Oregon State College. Research under these fellowships included soil testing for available potassium, fertilizer experiments in the field, potassium supplying power of Oregon soils, and leaf analysis studies. Currently, a project on the potassium status of soils and crops in southern Oregon is being supported by a research grant.

Looking back over the past 20 years, Institute activity in support of research has not only produced the basis for increased potash use, but has also made possible important contributions to knowledge of the potassium status of Western soils and the potassium nutrition of crops.

Institute Participation in Fertilizer Industry Activities

The broad policy of helping to develop increased use of all fertilizer

Fig. 5. Discussion panel at the second annual California Fertilizer Conference. Left to right: Ralph Waltz of the fertilizer industry, Messrs. Embleton, Lilleland, Lorenz, Mikkelsen, and Aldrich of the University of California.

through educational and promotional methods has characterized Institute activity in the West. It has always been realized that increased potash use depends in no small degree upon developing the use of other plant nutrients as well. Therefore, Institute personnel have given freely of their time in any research, educational, and promotional activities which would ultimately be of lasting benefit to the entire fertilizer industry.

The Pacific Coast Manager took an active part in the formation of the Soil Improvement Committee of the Pacific Northwest Plant Food Association. After its formation this committee's activity was guided by the Institute fieldman as its chairman. The creation of a plan for farm improvement demonstrations is one of the outstanding accomplishments of the committee. One of these farms, the Benedict Farm in Whatcom County, Washington, has become widely known for its transformation from an unproductive venture to a profitable farming operation, through the use of recommended practices including the use of NPK fertilizers on pasture and hay land.

The committee realized the need for a fertilizer meeting where all interested persons could come and get the latest in soil fertility information and discuss current problems in this field. Such a meeting was programmed, is now held each year, and is known as the Pacific Northwest Annual Fertilizer Conference.

In California, the Manager has been active in the California Fertilizer Association Soil Improvement Committee and in later years served as its chairman. The Committee activities have included the creation of the Annual California Fertilizer Conference, now in its third year and serving a growing need for the dissemination of the best soil fertility and plant nutrition information available. There have been many other useful accomplishments, including publication of the Western Fertilizer Handbook, now in its second edition; the production of the moving picture film "California Grows with Fertilizer;" yearly fertilizer essay contests and scholarship awards to agricultural students in soils and crops; and the placing of grants-in-aid for fertilizer research with the University of California.

Progress With Potash in the West

Early in the Institute's existence, very little basis for potash usage had been officially established in the West. It became the task of the Institute staff to expand this base through research, adding foundation stones, one by one, until the need for potash was recognized. This was done through an active program of cooperative research and field experimentation with the experiment stations and agricultural extension services of the various states. Such a program will continue to be productive in the West for many years. At this point, however, it can be said that the "pioneering" work has been done, and that a foundation for potash need and for the future development of that need has been quite firmly established.

Through participation in soil-testing research, the Institute has developed a much greater knowledge of the potassium status of Western soils.

Active interest in leaf analysis research has resulted in another useful diagnostic tool for determining the potassium status of many Western crops.

Cooperative effort in field surveys of nutritional status of crops and in field experiments with fertilizers has resulted in locating many areas of potash need. Studies of potash response in the field have resulted in more information on sodium-potassium relationships and potassium-magnesium relationships, in more effective application methods for potash fertilizers, and have added materially to the knowledge of potassium-deficiency symptoms on plants.

Cooperative effort has taken the form of financial assistance, donations of fertilizer materials, or field assistance and assistance with chemical analyses by members of the Institute staff, all with the object of facilitating the collection of useful information.

Potash in Canada

(From page 26)

tario, which is predominantly a dairy district requiring ample leguminous roughage, corn for silage, and abundant pastures. Unfortunately, the soils never were particularly fertile, and with neglect that has been common in many areas a great many poor crops were in evidence.

One of the objects of the fellowship was to determine whether these soils could be more rapidly brought back into a state of productivity if larger applications of fertilizer were applied, these to be based on the results of a soil test. Three permanent fields were chosen in representative sections of eastern Ontario. Results on each of these areas have been markedly significant and profitable. In one particular case, by the proper use of fertilizers the forage was increased from a ton and one third to more than six tons per acre. Not only was the tonnage substantially increased, but the protein was increased by five times and the phosphorus by ten times. In spite of the quite substantial amounts of fertilizers which were applied to give these high yields, the practice was found to be a paying one, and the profit rose from $19.11 on the poor plot to $86.78 on the plot which had received high applications of fertilizer, based on the results of soil tests.

These and similar field trials in eastern Ontario, carried on under this fellowship, have been very impressive among the farmers, and the demands for soil testing have grown very rapidly.

Fellowship at the Institut Agricole d'Oka, La Trappe, P. Q.: In July 1941, a fellowship was established at the Institut Agricole d'Oka with similar aims to those of the one established at Ste-Anne-de-la-Pocatiere in the Lower St. Lawrence. Since the soils in the District surrounding Oka are much more fertile and differ widely from those found around Ste-Anne-de-la-Pocatiere, it was thought wise to introduce and encourage the use of soil-testing technique at this institution.

Checks were made on a great many farms and soil types in the District, and it was found that the modified Thornton test gave quite suitable results for that particular District. Mr. Belanger, who was chosen to conduct the work, gave very faithful service and at the termination of the fellowship was placed in charge of the soil-testing work at the Dominion Experiment Station at L'Assomption. In addition to this, a soil-testing laboratory is maintained at Oka to serve the needs of the farmers in that District.

Fellowship at Macdonald College, Ste-Anne-de-Bellevue, P. Q.: In July 1944, a fellowship was inaugurated in the Chemistry Department at Macdonald College to investigate some of the more fundamental phases of potash fixation, methods of analysis for potash, as well as the effects of various fertilizer combinations on nutrient uptake by crops. Several excellent papers have been published both in the "Journal of Agricultural Science" and the "Soil Science Society of America Proceedings."

Fellowship at Laval University, Quebec: In 1948 there was established a modest fellowship at Laval University in Quebec for the purpose of expanding grassland improvement work. Some outstanding fertilizer trials on grasslands at various farms in Quebec have been instrumental in creating a great deal of interest in grassland farming and the proper use of fertilizers for

grassland farming among the farmers of Quebec. Some of the results obtained on legume maintenance were outstanding as is shown in Figure 1.

The end result of the various fellowships provided by the Potash Institute in Canada has been a stimulation of research which through the ingenuity and progressive thinking of the research people involved has led to findings much more outstanding than originally hoped for when these fellowships were established. In a practical sense this research has been of great benefit to the Canadian farmer since it has shown him how fertilizers can and should be used as a tool to provide him with greater profits.

Diagnostic Techniques

The Institute program in Canada has placed great emphasis on how to find out as quickly and accurately as possible when and how much potash should be used. To accomplish this, the various diagnostic techniques have been promoted. The most widely used is that of soil testing. It is now almost universal in agriculture and in Canada tests are obtainable at a great many universities, experiment stations, and industrial laboratories. It is providing the basis for many of the fertilizer-use programs of farmers. In view of the public acceptance and confidence in soil testing, it is almost unbelievable that it was introduced in Canada only slightly more than 20 years ago. The historic picture (Figure 2) shows the first quick soil testing in Canada.

Advisory Fertilizer Boards

Reviewing 20 years of the Institute in Canada would not be complete without some mention of the Advisory Fertilizer Boards. These Boards are somewhat unique in that they offer a chance for Government officials, extension personnel, research staffs, and industry, as well as representatives of various important grower's organizations, to get together to discuss fertilizer recommendations and usage for the area concerned. The Advisory Fertilizer Board as formed in Ontario in 1935 is an official Government committee. E. K. Hampson, recently retired Canadian Manager of the American Potash Institute, has been a member of the Board ever since its inception.

Potash Trophy

In order to stimulate a greater interest in the production of seed potatoes in Canada, a trophy has been given by the Potash Institute for the best seed potatoes shown at the Royal Agricultural Winter Fair. The winner of this trophy has been designated as the World's Champion Potato Grower. The trophy itself, a gold watch, was given generally at a dinner in the home town of the winner. The dinner attracted wide attention and was usually attended by a great number of important agricultural people. Trophy and dinner combined served as a great incentive to the potato growers, since winning the watch and special dinner was an honour for which many growers of seed potatoes strived.

Demonstrations

The demonstration program of the Institute in Canada has been one of cooperation with any recognized agricultural agency to aid or advise in demonstrations which will show the value of better farming practices to farmers. It has not been possible for the Institute to carry on a demonstration program on its own due to the limitations of its staff and also because it is believed that such demonstrations are much more effective when carried on by official agricultural agencies, particularly the agricultural representative and experiment station personnel.

Cooperation With Industry

The cooperation that the American Potash Institute has enjoyed with the fertilizer industry of Canada has been one of the bright spots in its 20 years of existence. The Institute has always been an associate member of the Plant

Food Producers of eastern Canada, and its Manager has served on many committees of this organization.

Fertilizer Usage

Along with these various advances during the past 20 years has come a great increase in fertilizer usage in Canada (Table I). This increase has been necessitated by the depletion of soils and the desire to produce more and more crops annually. It has been brought about by the recommendations of the research and extension personnel in Canadian agriculture. On the basis of these recommendations, the use of potash has increased rapidly along with other major nutrients and mixed fertilizers.

Fig. 2. The first soil testing in Canada, 1934. Left to right—Prof. J. E. Howitt, Dept. Botany, O.A.C.; Dr. G. N. Hoffer, American Potash Institute; Dr. G. I. Christie, President, O.A.C.; Prof. Jas. Laughland, Field Husbandry Dept., O.A.C.; Prof. G. N. Ruhnke, Soils Dept., O.A.C.

The average analysis of mixed fertilizers has increased. In Ontario in the year ending June 30, 1935, only 13.2 per cent of the mixed fertilizers sold contained 10 per cent or more potash. In the year ending June 30, 1954, this percentage had increased to 79, on a tonnage basis.

The past 20 years of participation in Canadian agriculture have been very gratifying. Great progress has been

TABLE I.—CANADIAN CONSUMPTION OF MIXED FERTILIZER AND POTASH IN MIXED FERTILIZER FOR YEAR ENDING JUNE 30, 1934, AND JUNE 30, 1954

Province	Mixed Fertilizer tons		K_2O in Fertilizer tons	
	1934	*1954*	*1934*	*1954*
Prince Edward Island	7,842	42,447	757	4,544
Nova Scotia	14,222	25,947	840	2,062
New Brunswick	12,841	63,534	1,276	6,234
Quebec	15,404	122,828	1,300	12,177
Ontario	38,912	375,673	2,326	39,669
Manitoba, Saskatchewan, Alberta	68	689	3	48
British Columbia	6,607	15,998	547	1,550
Total	95,896	647,116	7,049	66,284

made and the future looks bright. Canadian agriculture is in capable hands and the Potash Institute hopes to be able to continue cooperating in an association for the betterment of Canadian agriculture and everyone connected with it.

Potash in the Northeast

(From page 16)

Fig. 7. Maryland medium broadleaf tobacco is prized for its free-burning quality. Official recommendations call for 1,000 lbs. per acre of 4-8-12 fertilizer on soils of low fertility and no cover crop turned under. On more fertile soils where legume cover crop is turned under, the same amount of 2-8-16 is used. About 2/3 of the total fertilizer should be applied in the row; the balance as a sidedressing at first or second cultivation. All potash should be in sulphate form and mixed fertilizer should always supply 2 per cent magnesium oxide.

Fertilizer recommendations, articles by official agricultural workers, and the tenor of discussions before scientific and farm audiences have reflected favorably the results of potash investigations. This increased emphasis on the role of potash in crop fertilization has been paralleled by a significant uptrend in potash usage throughout the territory.

While it has not been possible to maintain Institute research projects in every state, it has been a fixed policy, within the limits of funds available, to establish projects on a three-year basis as a minimum, to give major emphasis to research of a fundamental nature where a reasonable potential was to be expected, and from the long-time viewpoint to endeavor at all times to give consideration to the territory as a whole, moving to new projects and states as seemed desirable and equitable. In this fashion, the record reveals that projects of three years duration or longer have been supported in 10 out of 13 states and that in the remaining states facilitation of research or extension programs has usually been on a one-year-renewable basis.

Cooperative Demonstrations

As is well known, fertilizer recommendations by state agronomists, although related to research, are in the main based on field tests, in which are compared the beneficial effects of the

various plant nutrients in varying ratios, one to another. A great multiplicity of repetitions and other factors enter into the final conclusions as to what is best for a given crop to be grown under prescribed conditions of soil or climate. These finally appear as an official fertilizer recommendation. There still remains, however, the problem of convincing the farmer that the recommended is more profitable than his accustomed fertilizer practice. This sizable and extremely important task is best expedited through the device of demonstration. It is a never-ending task.

Since demonstrations are an important activity of the state agricultural extension services through the county agricultural agents, the Northeastern Office of the Institute has from its beginning endeavored to fit into this important activity. Donations of potash salts or special fertilizer mixtures and underwriting prizes for crop production essays or contests have been employed whenever, in the opinion of the cooperating agronomist, county agent, or vocational teacher, it seemed desirable.

A demonstrational enterprise that has inspired enthusiasm and yielded spectacular results is the New England Green Pasture Program, now grown to maturity in the National Grassland Program. Evidence was abundant showing that a mixture of legumes and grasses yielded superior results to grasses alone and that legumes growing in association with grasses supplied nitrogen in such amount as to limit the need for applied nitrogen. But because the legumes require liberal potash fertilization, Institute championing of the grass-legume program in the Northeast has from the first been a natural.

From heavy usage of phosphate and/or nitrogen to the present-day practice of liberal fertilization of grass-legume sods with lime, phosphorus and potash has become the agronomic decree and an economic necessity in

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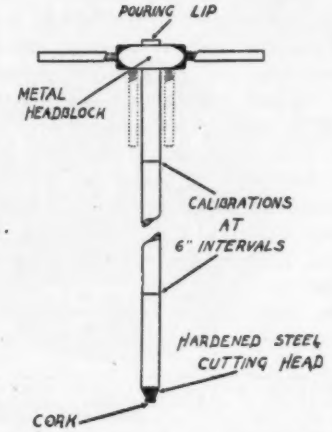

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the Northeast. Nitrogen in the grassland farming picture has and always will be important, but its place is primarily in areas and on soils where for other than nutrient requirement reasons, legumes cannot be successfully grown.

Cooperation with Industry

No discussion of the present status of potash in the Northeast would be complete without favorable mention of the fertilizer manufacturers, mixers, dealers, materials companies, and trade organizations, actively working for the advancement of agriculture through more efficient use of all fertilizers in a balanced fertility program. Each year since 1935 cooperation has more and more become the order of the day. Discussions of problems of mutual interest are not only welcomed but invited, making for teamwork of the highest type.

The Institute staff has maintained contact with key men in industry throughout the territory. Assistance has been given in such things as preparation of circulars, booklets, articles, and even advertising copy. On numerous occasions conferences have been held with sales groups on fertilizer problems. In our cooperation, the magazine, Better Crops With Plant Food, and its reprint service have become popular. Through this publication and the more personal territory mouthpiece, the Northeast Potash News Letter, industry as well as all others on the mailing list are kept reasonably well posted on agronomic thinking involving fertilizers in general and potash in particular.

Diagnostic Techniques

Prior to 1935 the use of chemical methods for determining the fertility status and nutrient requirements of soils and crops had not met with general acceptance in the Northeast. Every state made some attempt to test for lime requirement. Only three states

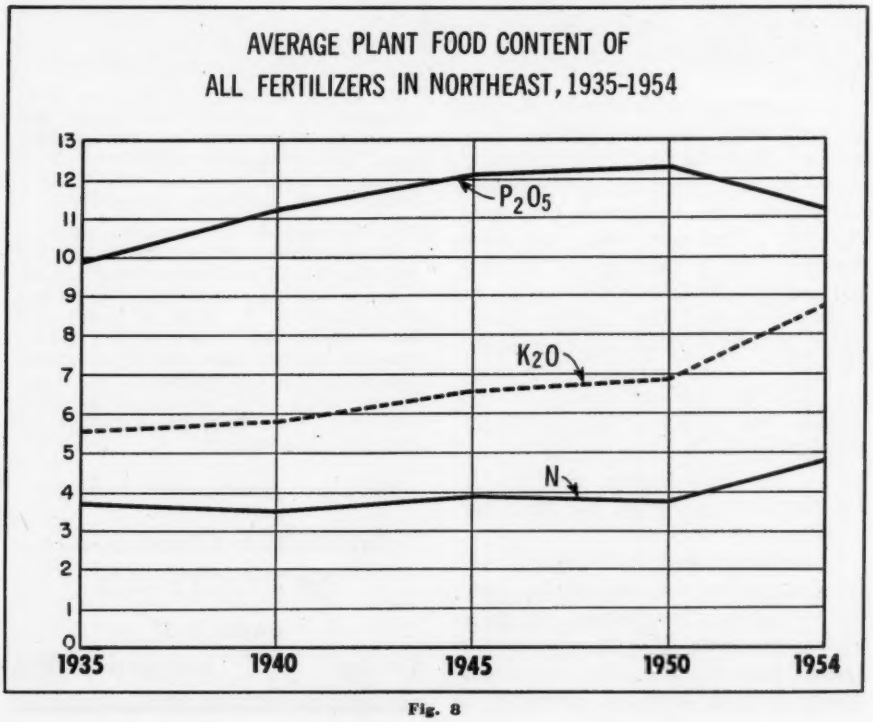

Fig. 8

were testing for other plant nutrients. Today, however, every state in the territory maintains a complete soil-testing service and the number of soils tested annually is increasing rapidly. This service is proving popular, and evidence indicates that the end result is more efficient utilization of the fertilizer used. Invariably this means more satisfactory farm income.

Other diagnostic techniques, such as tissue tests and leaf analysis, are used by research specialists and with a high degree of effectiveness on experimental plots where correlation studies are being conducted.

Among the diagnostic techniques for evaluating the productive power of soils, one that has shown great promise has been the recognition of plant-food deficiency symptoms. The so-called starvation signs associated with deficiencies of the various nutrients are the visible evidence of a physiological imbalance of the minerals in the plant. They therefore serve as caution or danger signals for guidance of the scientist or farmer. A prudent farmer who learns to recognize the danger signals soon realizes that corrective changes must be made in his soil-management and fertilizer programs.

Other phases of the deficiency-symptom picture that have been emphasized by the technical staff of the Institute include:

(1) The preparation and distribution of color charts showing typical potash-deficiency symptoms of important potash-consuming crops.

(2) Collection and distribution of kodachrome slides featuring potash deficiency to help keep the subject of potash before the farm advisers as well as the farmers. This slide service has been used widely and effectively by teachers, county agents, vocational instructors, and industry. Quite a few of these slides have been used in official Experiment Station bulletins, Extension, and industry handbooks and folders, scientific articles, and in articles in Better Crops With Plant Food.

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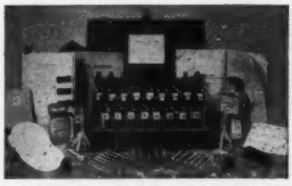

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(3) Potash-deficiency pictures that have been extensively used in the Institute motion picture activity. "The Plant Speaks Thru Deficiency Symptoms"—sound and color film—enjoys unusual popularity and from the beginning has been booked to capacity.

"In the Clover," also a sound, color picture, was developed by the Northeast staff. It features ladino clover, one of the potash-loving legumes.

While visual symptoms of nutrient deficiencies are in no sense a substitute for other fundamentally sound techniques, such as soil tests, tissue tests, and leaf analysis, they are to be accorded the status of a most valuable supplement. No fertilizer program should be based on crop symptoms alone any more than on any other technique alone. When deficiency symptoms occur, a soil test should be made and if the soil test and plant symptoms both indicate a deficiency for the same element, the trouble is identified. If there is still an element of doubt as to the deficiency status, a further check with the tissue test or leaf analysis technique will usually clear up the situation.

Trend in Potash Usage

In 1954 Northeast farmers bought more potash and other plant nutrients than in any previous year. Figure 1 shows that the increase in potash usage since 1935 has been relatively greater than fertilizer tonnage as a whole. This argues well for the forces that have been in operation in the interest of more efficient utilization of all fertilizers. The tremendous increase in higher analysis materials being made available offers possibilities of still higher analyses of mixed fertilizers, whenever the technical problems relating to their use have been solved.

The average plant-food content of all fertilizers in the Northeast is graphically shown in Figure 8. For potash the average has shown a progressive and significant increase.

A study of the five leading tonnage grades for each state in the Northeast reveals almost complete disappearance of once popular grades, such as 3-8-3, 4-8-4, 4-12-4, 2-8-5, and 2-8-2. These have been replaced in the main by fertilizer grades of higher concentration containing more potash. Experiment Stations are recommending higher potash fertilizers. For example, the average potash in all fertilizers recommended in Vermont in 1935 was 6.1%, while in 1954 it was 15.8%. In Virginia, recommendations averaged 6.4% in 1935, while in 1954 they were 13%.

The trend toward higher fertilizer concentrations, which was delayed during the war emergency, is now in full swing. With availability of materials required, resistance encountered in the early days of the movement has ceased to exist. The Institute has kept in constant touch with agronomic and industry thinking. In private conferences and fertilizer meetings the participation of staff agronomists has served to maintain appropriate emphasis on potash whenever grade discussions have been under consideration. Specifically, the 0-1-1 and 0-1-2 ratios for legume fertilization and the 1-0-1 ratio for side-dressing of row crops, now listed and widely used in the Northeast, have long been championed by the Institute.

Little Jim—"Daddy, a man's wife is his better half, isn't she?"

Father—"Well, son, they are frequently referred to as such."

Little Jim—"Then if a man married twice, there wouldn't be much of him left, would there?"

A merchant on 14th Street put up a display of evening dresses and with it the following sign:

"These dresses are like a fence. They protect the property but do not obstruct the view."

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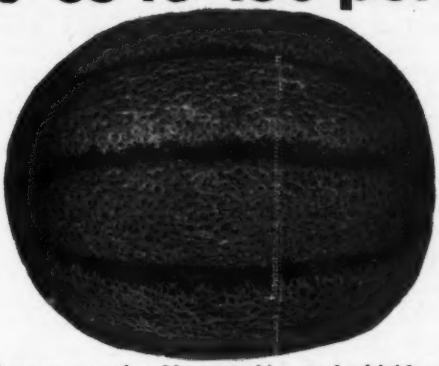

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One experiment revealed that cucurbit yields were actually doubled by a pre-emergence application of Alanap-1. "Plants in untreated rows were severely stunted by weed competition before the fields could be cultivated and hoed, whereas treated rows were still not suffering... two months after planting."

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FREE LOAN OF EDUCATIONAL FILMS

The American Potash Institute will be pleased to loan to educational organizations, agricultural advisory groups, responsible farm associations, and members of the fertilizer trade the motion pictures listed below. This service is free except for shipping charges.

FILMS (ALL 16 MM. AND IN COLOR)

The Plant Speaks Thru Deficiency Symptoms (Sound, running time 25 min. on 800-ft. reel.)

The Plant Speaks, Soil Tests Tell Us Why (Sound, running time 10 min. on 400-ft. reel.)

The Plant Speaks Thru Tissue Tests (Sound, running time 14 min. on 400-ft. reel.)

The Plant Speaks Thru Leaf Analysis (Sound, running time 18 min. on 800-ft. reel.)

Save That Soil (Sound, running time 28 min. on 1200-ft. reel.)

Borax From Desert to Farm (Sound, running time 25 min. on 1200-ft. reel.)

Potash Production in America (Sound, running time 25 min. on 800-ft. reel.)

In the Clover (Sound, running time 25 min. on 800-ft. reel.)

In Canada: The Plant Speaks Thru Deficiency Symptoms

The Plant Speaks, Soil Tests Tell Us Why

The Plant Speaks Thru Tissue Tests

The Plant Speaks Thru Leaf Analysis

Borax From Desert to Farm

Potash Production in America

DISTRIBUTORS

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Southeast: Vocational Film Library, Department of Agricultural Education, North Carolina State College, Raleigh, North Carolina.

Lower Mississippi Valley and Southwest: Bureau of Film Service, Department of Educational Extension, Oklahoma A & M College, Stillwater, Oklahoma.

Midwest: Visual Aid Service, University Extension, University of Illinois, Champaign, Illinois.

West: Department of Visual Education, University of California, Berkeley 4, California.

Department of Visual Education, University of California Extension, 405 Hilgard Ave., Los Angeles 24, California.

Department of Visual Instruction, Oregon State College, Corvallis, Oregon.

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Canada: National Film Board, Ottawa, Ontario.

For the Province of Ontario: Distribution Services, Ontario Agricultural College, Guelph, Ontario.

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Requests should be made well in advance and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of loan.

Request bookings from your nearest distributor.

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

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S-5-40 What is the Matter with Your Soil?
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
A-1-44 What's in That Fertilizer Bag?
P-3-45 Balanced Fertility in the Orchard
Z-5-45 Alfalfa—The Aristocrat
OO-8-45 Potash Fertilizers Are Needed on Many Midwestern Farms
ZZ-11-45 First Things First in Soil Fertility
T-4-46 Potash Losses on the Dairy Farm
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TT-11-47 How Different Plant Nutrients Influence Plant Growth
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X-6-48 Applying Fertilizers in Solution
AA-6-48 The Chemical Composition of Agricultural Potash Salts
GG-10-48 Starved Plants Show Their Hunger
SS-12-49 Fertilizing Vegetable Crops
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CC-12-52 The Leaf Analysis Approach to Crop Nutrition
I-2-53 Sericea Is a Good Drought Crop
J-3-53 Balanced Nutrition Improves Winter Wheat Root Survival
K-3-53 Kudzu Keeps Growing During Droughts
N-4-53 Coastal Bermuda—A Triple-threat Grass on the Cattleman's Team
P-4-53 Learning How to Make Profits from Sweet Potatoes
T-5-53 Trefoil Is Different
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GG-8-54 Effect of Boron on Beets and Crops Which Follow
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A gentleman was dining at an exclusive restaurant. His veal chops were rather tough, so he called the waiter over to complain.

Diner: "Waiter, these chops are much too tough to be veal."

Waiter: "I can assure you, sir, that they are veal. I was a butcher once and I can tell you that not more than three months ago that meat was on the hoof, following the cow around."

Diner: "Probably so—but not for milk!"

* * *

"Mary, Mary, quite contrary,
How does your garden grow?"
"With bugs
And slugs
And blight
To fight,"
Said she, "I hardly know."

* * *

A Texan who was visiting in California had been boasting about the healthful qualities of the Texas climate and as proof mentioned that his father, who was 75, still rode horseback. One of his listeners allowed that that was pretty good, but that it couldn't come up to a neighboring Californian the same age who had spent ten hours every day the past week plowing—except Saturday afternoon, when he had to knock off to go to his father's wedding.

"How old is his father?" asked the Texan.

"Ninety-nine."

"What did he want to get married for at that age?"

"Want to? He had to!"

A saintly looking old fellow was running to catch his bus. Just as he appeared to be winning the race, the bus driver pulled away from the curb—and the wheels splashed a shower of muddy water over the old man. Softly, this kindly old soul murmured, "May his soul find peace." Still more softly he added, "And the sooner the better."

* * *

In the old days when a youth started sowing wild oats, father started the thrashing machine.

* * *

Jack: "I just got a letter from Wisconsin today. It tells me of a cousin of mine breaking a bottle of turpentine in his hip pocket."

Jim: "What happened?"

Jack: "No one can say just yet. They haven't been able to catch him."

* * *

There is a magic moment at every summer resort. It comes at dusk, in that tiny interval of time when flies have knocked off for the day and mosquitos have not yet taken over.

* * *

In these days of low-cut gowns, tight-fitting waists and sheer stockings it takes will power for a man to look a woman in the eye.

Cauliflower: left, boron treated; right, brown curd with boron deficiency

Alfalfa yellows and rosetting due to boron deficiency

EXAMPLES OF BORON DEFICIENT CROPS

Apples with external cork cracks, necrotic areas and dwarfed

Tobacco with die-back of terminal bud rolling of upper leaves

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